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ANNALS

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ENTOMOLOGY IN CHINA[1]

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The subject of Entomology in China presents a somewhat anomalous combination of the old and the new: time-honored customs and methods fresh from the modern laboratory. China, while it is the point of origin of many of our sciences, is also one of the areas of greatest backwardness, in the modern sense, among the larger nations of the world. At least the latter would no doubt be the impression received by an entomologist from this country in traveling through many parts of China today. Thus entomology in China, a land of contrasts, includes a peculiar mixture of ancient and modern practices. For instance, in the same area one might find farmers burning joss sticks before a shrine or shooting off firecrackers for the general protection of their crops from insects, weather or other destructive forces; other farmers picking or sweeping certain pests from their crops with their hands or home-made implements; and students or extension workers doing small-scale testing of insecticides on the same crops.

Early Entomology.—The Chinese people have, of course, made some of the earliest discoveries in the field of entomology, if not most or all of the first discoveries. History shows that the Chinese unquestionably first domesticated the silk worm. They have also brought other silk moths to a state of semi-domestication. Dr. Van Dyke informs me that in the sacred Chin Shan range of southeastern Manchuria he saw Chinese transferring submature larvae, probably of *Antheraea*, in large numbers on trays from one feeding area to another as the scrub oak foliage was consumed. The honey-bee may have been domesticated in China as early as it was in Egypt. The hives still used almost throughout the country are of primitive types, consisting of hollowed sections of logs such as palm trunks, or baskets made of woven bamboo. Chinese white wax, made from the Pela scale, *Ericerus pela*, is an ancient dis-

[1]I gratefully acknowledge the assistance of A. M. Boring, H. F. Chu, W. E. Hoffmann, T. Y. Hsiao, C. S. Lee, Y. P. Sun and E. C. Van Dyke in supplying certain information.

covery; its production has been encouraged during the war (Chiao & Peng, 1943), just as has silkworm raising.

Various insects are used in China for food to this day. These include giant water bugs (*Lethocerus*), large water beetles (*Cybister*), social wasp larvae and pupae, and "bees" (Steward & Cheo, 1937). The water bugs and beetles are commonly seen sold in the streets of Canton and Hong Kong. Quite a number of different types of insects, both larvae and adults, are sold in certain markets in Canton and elsewhere to serve as food for cage birds, since many of the beautiful birds the Chinese like to keep in cages are insectivorous.

A number of insects have been used as drugs in China. Among these are *Chu Ki*, a fulgorid, *Lycorma delicatula* (Liu, 1939-a), the nymphal shed skins of various species of cicadas, and the dog-fly, *Hippobosca longipennis*. For smallpox the latter are soaked in wine and drunk with the wine; for malaria the flies' appendages are removed and the bodies are made into pills with dough and taken on the morning of the day the next attack is due, vomiting being necessary to make the treatment successful (Bequaert, 1939). Dried dragon flies, cockroaches, cicada nymphs killed by fungus (*Cordyceps*) and other insects also form a part of the Chinese *materia medica*. The cockroaches, when eaten, are said to rid children of intestinal worms. (A parasitologist could hardly refrain from reacting to this by saying that if the child didn't already have worms before taking the treatment, he certainly should afterwards.)

Insects are also used as a source of entertainment in China. Crickets have been used in China for fighting exhibitions and gambling since 960 A. D. or longer. Special equipment has been developed for catching the crickets, housing them in summer and winter, day and night; for female oviposition, for feeding, for exciting them to fight and for cleaning their cages. All of this equipment is elaborately carved or molded of ivory, jade, special wood, porcelain or other materials. One type of container for winter quarters was made by an elaborate technique, no longer practiced, of forcing gourds to grow in various shapes with special patterns in relief on them by introducing the flowers into earthenware molds.

Raising these insects is a regular profession; people may have rooms full of stacked jars in which the crickets are reared, with a resulting din. Some wealthy people employ their own cricket experts. The crickets' wings are often thinly coated with wax to improve the sound. This is done by means of a blunt needle. Champion fighters are bred by artificial selection. They are fed on gorged mosquitoes and are given special treatment during sickness. A champion may be worth as much as a horse; at death it is buried in a special coffin with ceremony. (Laufer, 1937).

Various species of singing insects, such as crickets and long-horned grasshoppers (katydids) of various types are sold in miniature cages to take home and hang up in the house, so that their singing may be enjoyed. This custom is said to have arisen about 618 A. D. Crickets are mentioned in the earliest collection of Chinese popular songs (*Shi-king*). The insects are fed with sliced cucumber or lettuce in summer and masticated chestnuts and yellow beans in winter, the

feeding differing for the various species. Species caged for singing or fighting include the crickets *Gryllus conspersus* and *G. mitratus*, *Homoeogryllus japonicus*, *Loxoblemmus taicoun* and *Oecanthus rufescens*, and the katydids *Gampsocleis inflata* and *G. gratiosa infuscata*.

Cicadas are mentioned in Chinese literature at least since 500 B. C. There is an old custom of placing a jade cicada in the mouth of a corpse upon burial to help the soul in leaving the body. This custom is said to have arisen because of the observation of cicada metamorphosis and of the adults coming out of the earth. These tongue-amulets can still be bought in Canton and elsewhere. It is said that in the past cicadas have been caged as singers. Certain of the Chinese species do have songs that can be appreciated.

In the Shang Dynasty (1766–1122 B. C.) cicadas already held a regular place in Chinese decorative art (Myers, p. 4). Cicadas as well as many other insects feature prominently in Chinese art, including paintings, embroidery, porcelain, woodcarving and jade and other stone images. Many of the representations of insects, such as butterflies, moths, beetles, katydids, mantids, honey-bees and others, particularly those painted on silk or paper, can be definitely identified to the species. Most of the paintings the writer has seen could be placed rather easily. Sowerby (1940) has discussed insects in Chinese art.

Fireflies were a source of entertainment in China at least as early as 616 A. D., tremendous quantities being gathered and liberated when the emperor climbed to the top of a hill on a certain evening to view the sight. Fireflies are still collected by Chinese children and placed in empty egg-shells (Liu, 1939-a). Rhinoceros beetles (*Xylotrupes dichotomus*, *X. gideon*), stag-beetles, june-beetles, bamboo weevils (*Macrocheirus longipes*), lantern flies (*Fulgora candelaria*) and others are caught by children and tied to stones or bamboo sticks with lengths of string, for amusement. Certain of the larger buprestids, such as *Chrysochroa fulgidissima*, are used as ornaments.

Dr. Gaines Liu (1939-b) has described what he calls the "earliest Bureau of Entomology," the plans for which were outlined probably in the 12th century B. C. The proposal included personnel, function and methods under each of five divisions: (1) insect borers, (2) household pests, (3) frog control, (4) aquatic vermin, and (5) poisonous *Ku* (probably internal parasites). Though some of the control methods involved propitiation, others included fumigation or spraying with plant products.

A number of primitive methods of insect control are used in all parts of China to this day. I have seen farmers in northern Formosa using specially constructed basket-like nets of woven bamboo on bamboo handles swung like a sweeping net through the tops of growing rice plants to collect the adults and larvae of the leaf beetle *Lema oryzae* and adults of *Hispa*. These leaf-beetles are important rice pests in South China and Formosa. It is a common sight throughout the same regions to see large flocks of ducks being slowly driven through the rice paddies to feed on the insects, snails and crustaceans that inhabit them. Geese and chickens are to some extent used for the same purpose.

Prof. Hoffmann (1935) reports than in an out-of-the-way locality in Kwangtung Province he found a method of white-grub control which consisted of placing bunches of old rice-straw containing dirt up among

the branches of trees. This provides a highly suitable egg-laying site for the june-beetles, and after the laying season is over the bundles of straw are taken from the trees and burned, thus destroying the larvae and eggs. Dr. Van Dyke tells me of finding a farmer near Nanking busily occupied digging up the wire-worms and adults of the click-beetle *Pleonomus canaliculatus* from around the bases of bean plants in a field. Methods such as these and others indicate a close familiarity with the habits of the agricultural pests on the part of the Chinese farmers; on the other hand, some practices or lack of certain precautions indicate lack of knowledge or mistaken ideas regarding other insects. Many measures for control are used which involve simple mechanical methods such as collecting or killing. Even entomologists are forced to make control recommendations of this sort for farmers. The Canton Government has in the past paid bounties for extensive collecting of Lychee stink-bugs, and at Lingnan University we have to a considerable extent satisfactorily advocated the hand-picking of certain insect pests, the catching of june-beetles at night by attracting them with the light of torches, the use of wires and tools for the destruction of termite nests and for extracting long-horned beetle larvae from trunks of living fruit-trees, as well as cultural methods (Hoffmann, 1934; Gressitt, 1942-a). Many cultural techniques have been gradually evolved by the Chinese farmers in response to the attacks of insects on their crops, though there is still much room for advancement.

The earliest record of biological control of insects is found in Chinese literature of about 900 A. D.; and the species referred to, the Citrus Red Ant, *Oecophylla smaragdina* Fabr., is still used in South China for the control of *Citrus* pests (Groff & Howard, 1924; Liu, 1939-a; Gressitt, 1942-a). The nests are annually brought from the hills in bags and sold in the markets of the Canton delta to the orchardists, who place them in the *Citrus* trees. The nests are made of leaves and silk-like material, and occur naturally in the branches or crotches of trees. The ant is red, about one-half inch long, has long legs, and is very ferocious. I suffered considerable inconvenience from the bites of this species while collecting parasites of the red scale insect in Hong Kong and Canton for the University of California Citrus Experiment Station during 1940 and 1941. There is some question in the writer's mind about the value of this species, since it tends certain unarmored scale insects, as do many ants. However it undoubtedly discourages many pests because of its predaceous habits. Another ant, a smaller, less vicious, black species, is also found in the orchards, no doubt naturally. Its nest is built entirely of paper-like material, being stiffer and heavier than most wasp nests; it is found in the upper or outer branches of the trees. Being less predatory, its value is probably even more doubtful.

There is a general impression among the Cantonese that the presence of certain black ants around houses will prevent the inroads of termites; but this is questionable, at least as far as generalizations are concerned, until all the ant species have been evaluated.

The chemical control of insects also apparently had its beginnings in China, probably at least as early as the 12th century B. C. (Liu, 1939-b). The methods of the "earliest Bureau of Entomology" included fumigation with *Illicium anisatum* and spraying with the ashes of *Chrysanthe-*

mum (pyrethrum), as well as the use of lime. The first is still used in South China. At the present time in some parts of China tobacco stubs are planted with individual rice transplants to combat the paddy borer, and scientific tests have shown control and increased yield. In Canton rings of tobacco ash mixed with cigaret stubs surrounding young transplants seemed to have some beneficial effect against cut-worms. This was tried in the Canton internment camp where no other insecticide was available. The milky juice from crushed fresh *Derris* roots has been used for centuries as an insecticide by the Chinese (Roark, 1931). The natives on Hainan Island and elsewhere have used *Derris* as a fish poison since early times. In Kwangsi Province fire-crackers have been used to combat tree borers. The crackers are fired in the burrows and the outer openings sealed promptly to retain the fumes.

Entomology in Modern China.—To one going to some of the usual sources dealing with history of entomology to seek for information on entomology in China, it might prove a revelation to find that no mention at all is made of China in such a book as L. O. Howard's "History of Applied Entomology." And this in spite of the fact that nine pages are devoted to Japan and 28 to Asia exclusive of the Philippines.

In attempting to explain this briefly, it might be said that the backwardness of China in entomology is largely a reflection of the delayed unification of the nation, the relatively low economic level of so much of the country, the inadequate financing of government programs, education and research, the high illiteracy, and such handicaps. However, to be quite fair it must be emphasized that rapid advancement is taking place at the present time, in spite of the added difficulties during the war.

It might be stated that modern entomology began to develop in China only about a quarter of a century ago. The first organized scientific control measures were inaugurated in 1917 when egg-mass collecting of the rice-borer (*Schoenobius incertellus*) was begun in eastern China. In 1920 a field station was established by the National Southeastern University for the study of the cotton geometrid (*Boarmia*), and in 1922 this was superseded by the Bureau of Entomology of Kiangsu Province, organized at Nanking with Prof. C. W. Woodworth as the first director (Woo & Hsu, 1935). Also in 1922 the *Lingnan Science Journal* (then the *Lingnaam Agricultural Review*) commenced publication. This is the oldest and best known periodical in China dealing primarily with the biological and agricultural sciences. In 1924 the Chekiang Bureau of Entomology was established, and in 1926 the *Peking Natural History Bulletin* started publication. The Department of Entomology and Plant Pathology of the National Agriculture Research Bureau was organized at Nanking in 1933, after the abolishment in 1932 of the Kiangsu Bureau of Entomology, mentioned above.

The first modern entomological paper known to me to be published in China was an article on sericulture by C. W. Howard (1922) of Lingnan University, which appeared in the first number of the *Lingnan Science Journal*. A short entomological note also appeared in the same issue (Campbell, 1922). Of course many Chinese insects had previously been described in European literature, even back to the

time of Linnaeus. Summarizing an analysis made a decade ago (Ouchi, 1934-b), it may be said that the numbers of entomologists having published on Chinese insects, arranged by countries, place the important contributing nations in the following order: (1) Germany, (2) England, (3) France, (4) Austria, (5) Russia, (6) China, (7) U. S. A., (8) Belgium, (9) Holland, (10) Italy, (11) Hungary, (12) Sweden and (13) Japan. The important countries arranged in the order of numbers of Chinese insect species described by specialists of those countries are: (1) England, (2) France, (3) Germany, (4) Russia, (5) Belgium, (6) Austria, (7) U. S. A., (8) Roumania, (9) China, (10) Holland, (11) Italy, (12) Czechoslovakia, and (13) Hungary, with Japan 18th on the list. The work done during the past decade would raise slightly the relative position of China, Japan and the United States on these lists. As to work actually published in China, the three ranking nations are China, the United States, and France.

As far as the encouragement and furthering of entomology in China by other countries is concerned, the United States has been the main contributor, with France second. Much of this contribution has been made through the colleges in China originated by Americans, notably Lingnan University, Yenching University and the University of Nanking. Chinese entomologists have expressed to me their feeling that the person who has contributed the most to entomology in China is Professor William E. Hoffmann of Lingnan University, through his long editorship of the *Lingnan Science Journal*, his work on economic insects in China, and his building up of the Lingnan Natural History Survey and Museum, as well as his teaching and advisory activities. Other American entomologists who have taught and helped organize work in China include Prof. C. W. Woodworth, Dr. C. W. Howard, Dr. J. G. Needham, Dr. W. A. Riley, Dr. E. C. Van Dyke, Prof. C. R. Kellogg, Prof. B. A. Slocum and Prof. A. W. March. The last two are still in China.

The French have built up two of the best museums in China: Musée Heude at the Université l'Aurore in Shanghai and Musée Hoang-Ho Pei-Ho in Tien-tsin, and have carried on teaching in the associated universities. The name of Rev. Father Octave Piel, of the former institution, will long be remembered in connection with Chinese entomology.

In discussing entomology in China particular mention should be made of Dr. C. F. Wu of Yenching University, well known for his many students, his catalogues of Chinese insects (1935–41) and his work on aquatic insects, Dr. Wu had his advanced training at Cornell University, as have many Chinese entomologists—another way in which Chinese entomology has profited by its association with the United States.

The principal institutions in China dealing with entomology are listed in Table I, together with entomologists and entomological publications connected with them.

Entomological articles appear in about 45 periodicals in China, published by about 35 institutions or societies. Entomological courses are taught in over 20 colleges or universities in China.

TABLE I

INSTITUTIONS, ENTOMOLOGISTS AND PUBLICATIONS IN CHINA DEALING WITH ENTOMOLOGY[2]

Institutions	Entomologists	Publications	Languages used in Publications
Academia Sinica	S. H. Chen; Y. Y. Zia; B. Young	Sinesia	E, (C).
National Academy of Peiping	H. F. Chu	Zoologia Sinica	E, (C).
Fan Memorial Inst. Biol.	W. I. Yang	Bulletin (Zool. Ser.)	E.
National Agric. Res. Bur.	F. C. Woo; H. T. Feng; Gaines K. C. Liu; Gideon T. W. Liu; Y. P. Sun; T. S. Cheng; P. T. Sun; K. O. V. Lieu.	Special Publications	C, E.
		Misc. Publications	C.
		Nung Pao	C.
(Kiangsu Bureau Entom.)	(Discontinued)	Technical bulletin	C, (E).
Chekiang Bureau Entom. (Hangchow)	Y. H. Tsou; S. C. Wu	Entom. & Phytopath	C, (E).
		Yearbooks	C, E.
		Misc. Publ. (1930-)	C, (E).
Kwangsi Agr. Exp. Sta	C. Y. Liu; Y. F. Hsu; S. L. Hwang; S. N. Chiang	Kwangsi Agric	C.
Kwangtung Bur. Agr. & For.	K. S. Chan	Technical Bulletin	C, (E).
Nat. Peking Univ			
Nat. Central U., Agr. Coll.	T. L. Tsou		
Nat. Tsinghua U. Agr. Coll.	C. L. Liu; C. J. Luh; Y. T. Mao; H. Y. Fan		
Nat. Chekiang U., Agr. Coll.	P. H. Tsai; T. C. Maa	Reports	C.
Nat. Shantung U., Agr. Coll.			
Nat. Szechuan U., Agr. Coll.	S. Tseng		
Nat. Sun Yat-Sen U. Ag. Coll.	S. F. Chiu; S. Lin; S. Chui; Chow Yung	Sci. Reports	C, (E).
Lingnan U.; Lingnan Nat. Hist. Surv. & Mus.; Ag. Coll.; Biol. Dept.	W. E. Hoffmann; Y. C. Ng; Y. W. Djou; J. L. Gressitt; C. T. Cheng	Lingnan Sci. Jour.	E, (C).
		Lingnan Sci. Bulletin	E.
		Lingnan Agr. Jour.	C, (E).
		Special Publ. N. H. Survey	E.
Yenching U., (Peking Nat. Hist. Soc.)	C. F. Wu; T. P. Chang; J.C. Li.	Peking Nat. Hist. Bulletin*	E.
U. Nanking, Coll. Agri.	B. A. Slocum; K. F. Chen; C. S. Tsi	Agric. Forestry News	C.
W. China Union U. (W. China Border Res. Soc.)	M. C. Chang; D. S. Pen	J.W.China Border Res.Soc.*	E, (C).
Fukien Christian U.	C. R. Kellogg	Proc. Nat. Hist. Soc. Fukien Chr. U	E, C.
Hangchow Christian Coll.	A. R. March		
Tung-wu U. (Soochow U.)		Biol. Supply Service Bull.	C, E.
St. John's U		Jour. St. John's Sci. Soc.	E.
U. Hong Kong	C. S. Ng; S. W. Ling	Hong Kong Naturalist*	E.
Musee Heude (U. l'Aurore)	O. Piel; B. Becquart	Notes d'Ent. Chinoise	F, E.
Musee Hoangho-Peiho			
China Soc. Arts & Sci.		China Jour. Arts & Sci.	E.
N. China Royal Asiatic Soc.		Jour. N. China Royal Asiatic Soc	E.
Sci. Soc. China		Biol. Contr. Lab. Sci. Soc. China	E, (C).
Agric. Assoc. China		Jour. Ag. Assoc. China	C.
Nat. Med. Assoc. China.		Nat. Med. Jour. China	E.
Chinese Med. Assoc.		Chinese Med. Jour.	E.
Henry Lester Inst. Med. Res.	S. M. K. Hu		
Nat. Hist. Soc. China		Jour. Nat. Hist. Soc. China (?)	
Shanghai Sci. Inst.	Y. Ouchi (Japanese)	Jour. Shanghai Sci. Inst.	E, C.

[2] E = English; C = Chinese; F = French. Parentheses indicate that the second language is used in abstracts, or for occasional articles. An asterisk indicates that it is not an official publication of the institution, though generally representing a society more or less associated with the institution. I must apologize for the many omissions in the table, and possibly some errors as well. A few of the above-listed entomologists are at present in the United States.

Agricultural Entomology.—The National Agriculture Research Bureau has one or more branch experiment stations in almost every province. Some of these are devoted to particular crops, and others deal with all types of local agricultural problems. Most of these have one or more entomologists attached to them. Much of the field work in agricultural entomology is carried on through these experiment stations and certain of the national or private universities.

The agricultural insect problems of China are too numerous to discuss or enumerate. Almost every one of the many crops has a number of insects attacking it in one way or another. Native plants, such as rice, *Citrus*, banana, tea, *Prunus*, lychee, mulberry, and others closely related to native plants, such as fig and various vegetables, are attacked by large numbers of insect species. Some of the pests attacking these are very serious pests in certain other countries where they have been accidentally introduced. Most of these latter are relatively less serious in China because they are naturally attacked by parasites or predators. Pests of stored food products are of very great importance, because of the common small-scale, essentially unprotected storage, and the importance of grains, such as rice, corn and wheat. It is practically impossible to keep dried fruit by ordinary methods in South China.

Knowledge of the agricultural insect pests of China is very incomplete. Though a fair amount of work has been done on certain species, many are very poorly known. In fact many are hardly known at all, or have not been identified. It is still possible to collect new species of moderately important economic insects in China. Much work of a pioneering nature remains to be done on the identification and biology, as well as control, of crop pests. Cheo (1936–7) published a list of agricultural insects of China which was admittedly preliminary in nature. Prof. Hoffmann has been working for some years on a host-catalogue of agricultural insects for South China. He has also published (1934) life-histories of many economic insects. At present Cecil S. Lee, at Cornell University, is preparing a list of Chinese agricultural insects. F. S. Li (1940) published a text in Chinese on economic entomology in China.

Among the most important insect pests of agriculture in China may be mentioned the following:

Locusta migratoria Linn. (Acridiidae)—On rice, corn, etc.
Tessarotoma papillosa Drury (Pentatomidae)—On lychee.
Nephotettix apicalis Drury (Cicadellidae)—On rice.
Aphis gossypii Glover (Aphididae)—On cotton.
Sitotroga cerealella Olivier (Gelechiidae)—In stored food.
Schoenobius incertellus Walker (Pyraliade)—On rice.
Chilo simplex Butler (Pyralidae)—On rice.
Cirphus unipunctata Haw. (Noctuidae)—On various food crops.
Pieris rapae Linn. (Pieridae)—On crucifers.
Melanauster chinensis Först. (Cerambycidae)—On citrus and other fruit trees.
Phaedon brassicae Baly (Chrysomelidae)—On crucifers.
Sitophilus granarius Linn. (Curculionidae)—In stored food products.
Cylas formicarius Fabr. (Curculionidae)—On sweet potato.

In the field of agricultural entomology, special mention must be made of Dr. F. C. Woo (1934–5), chief of the Department of Entomology and Plant Pathology of the National Agriculture Research Bureau, and a student of Dr. Van Dyke. S. F. Chiu (1934) discussed insect pests in Kwangtung Province. Woo and Cheng (1934) reported on locust outbreaks in China, and Woo and Hsu (1935) discussed the general subject of Chinese agricultural entomology.

The development of control methods for the many agricultural pests is still in the early stage, even though certain materials have been used since very early times, as indicated above, in addition to mechanical methods. Actual chemicals have not been very extensively used, though certain arsenicals have long been utilized to limited extents. More recently the following have been experimented with in particular: lead arsenate, calcium arsenate, copper carbonate and oil emulsions. Because of the relative scarcity of appropriate chemical materials in China and the financial inability of the farmers to purchase them even when available, the tendency has been to use available insecticidal plant products. In recent years, and particularly during the war, research has been directed towards finding practical plant materials accessible to the farmers. Some of the plants tested (Hwang, 1941; Chiu, *et al*, 1942; Hansberry & Lee, 1943, Lee & Hansberry, 1944) have been made use of in local areas for long periods by Chinese farmers.

Among the plant sources of insecticidal materials are the following: cottonseed-oil and rapeseed-oil, for emulsions against apids; resin wash for *Citrus* scales; Szechuan bean seed (*Croton tiglium* Linn.), sheep poison (*Rhododendron sinense* Sweet) and *R. mollei* G. Don., in the form of extract emulsions, used as stomach poisons for the mulberry white caterpillar and other leaf-eating insects. The leaves, root or bark of "Roy-kung-teng" (*Tripteryguim Wilfordii* Hooker), *T. Forrestii* Loes, *Celastrus angulatus* Maxim and *C. rugosa* R. & W. are used to make sprays or dusts for *Phaedon brassicae* Baly and other leaf-eating insects. Various extracts of *Derris uliginosa* Benth., *D. elliptca* Benth., *Millettia* pachycarpa Benth., *Pachyrrhizus erosus* Urban, *Chrysanthemum cinerariaefolium* Trev., *C. roseum* Wev., and *C. Marshallii* Ach. are used as both contact poisons and stomach poisons, particularly the former, for various types of insects.

Medical Entomology: The first discovery of primary importance in the field of medical entomology was made in China, when Sir Patrik Manson, at Amoy in 1878, proved that *Culex fatigans* transmitted *Filaria bancrofti* to human beings. However this field, at least up to the start of the Pacific war, has been rather neglected in spite of its importance in China where standards of hygiene and sanitation are low. Research work has been carried on in only a few areas and very little practical control of disease-disseminating insects has been carried out. Many important diseases in China are carried by insects. Among these are malaria, dengue, filariasis, plague, typhus, murine typhus, relapsing fever, dysentery, kala-azar, leishmaniasis, encephalitis, Japanese B. encephalitis, and papatasi fever. Scrub typhus, which is also arthropod-borne, may also occur.

In South China, malaria, dengue and filariasis are very important. Because of the importance of rice and the necessity of flooding the

paddies, special methods must be used to control paddy-breeding vectors like *Anopheles hyrcanus sinensis* Wied. Since night-soil is the most important fertilizer in most parts of the country, and since houses, toilets and food markets are not screened, the various germ-carrying muscoid flies are of great importance. Because of the abundance of rats, fleas and lice, plague and the various forms of typhus are potentially dangerous, and epidemics occur from time to time, especially during floods and wars. The number of insects of medical importance in China will prove to be very large. Many of them are still unnamed.

Among those who have carried on research in medical entomology in China, particular mention must be made of Stephen M. K. Hu, who has worked extensively with mosquitoes in the Shanghai area (Hu, 1939, etc.). In addition may be mentioned K. Chang (1943), T. L. Chang (1940), C. Y. Chow (1940), E. C. Faust (1929), C. H. Meng (1943), R. G. Mills (1925), W. S. Patton (1926), W. A. Riley (1932), C. C. Wu (Yao & Wu, 1938) and Y. T. Yao (1938).

Systematic Entomology: In this field, as pointed out above, much of the work to date has been done by foreigners, particularly Europeans. Though begun early, in the modern sense, very much remains to be done. I feel that the outstanding Chinese research worker is Dr. S. H. Chen of the Academia Sinica, who studied at the University of Paris, as did his wife, Y. Y. Zia, also a sound systematic entomologist. Both have worked in the Coleoptera and the Diptera.

Among the various specialists who have made particular contributions to the systematics of Chinese insects may be mentioned J. G. Needham (1930) on dragon-flies; S. F. Light (1924) on termites; K. S. F. Chang (1939), Morgan Hebard, J. A. G. Rehn (1941) and E. R. Tinkham (1937) on Orthoptera; W. I. Yang (1939), W. E. China (1940), W. E. Hoffmann (1935), T. Y. Hsiao (1942), C. J. Drake, H. B. Hungerford on Hemiptera; Z. P. Metcalf, W. D. Funkhouser, Gaines K. C. Liu and R. Takahashi on Homoptera; M. E. Mosely (1942) on Trichoptera; S. H. Chen (1934), L. Fairmaire, W. Horn, R. Kleine, E. A. Chapin and J. L. Gressitt (1940, 1942-b) on Coleoptera; C. P. Alexander on Tipulidae; Y. Y. Zia and S. H. Chen (1938) on Trypetidae; C. T. Cheng (1940) on Syrphidae; C. Y. Liu (1939) on fleas; and C. E. Mickel (1933) on Mutillidae.

Ouchi (1934-a) has compiled a bibliography of Chinese insects, though it is incomplete. In recent years Japanese have been describing fossil, as well as recent, insects from North China and Manchuria. Some of these species have been described in the Japanese language.

The unsolved problems and needs of entomology in China are very great. Undoubtedly American entomologists and institutions will aid in placing entomology in China on a firmer basis during the critical postwar period, when so much help will be needed. Much progress will undoubtedly be made towards solving the many problems, and we may look forward to mutually advantageous co-operation.

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OBSERVATIONS ON THE CELLULAR ENCLOSURES OF THE MID-GUT EPITHELIUM OF PERIPLANETA AMERICANA

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The following investigation was undertaken in order to determine the presence, form, and distribution of the mitochondria in the epithelial cells of the mid-gut of *Periplaneta americana.*

This investigation is being reported because of the variation in results between the observations of Gresson (1), on the mid-gut of another member of this genera, *Periplaneta orientalis* and these noted here on *Periplaneta americana.*

Several interesting studies have been conducted on the histological structure of the mid-gut of closely related genera by Breakey (2), and Patterson (3). There still remains a controversy over the exact method by which the formation of new epithelial cells takes place from the germinal centers in the mid-gut. The question of the presence of a striated border on the digestive epithelial cells also offers a topic of discussion. Both of these points of interest have been discussed in part in this report in view of offering a contribution to a general agreement among investigators on these issues.

MATERIALS AND METHODS

When this investigation was begun a large number of specimens was collected for dissection. All the material prepared for study was dissected under physiological saline and immediately placed in the fixing solutions. Only the mid-gut was used for study.

Tissues for general histological study were fixed in Bouin's fluid and stained in Azan and Iron Hematoxylin. Sections were cut at 6 microns in thickness mounted in series. For observations of the mitochondria Bensley's and Regaud's fixatives were used; the latter proved more satisfactory. The sections were cut at 2–4 microns (mu) and stained with Acid Fuchsin and Methyl Green.

Sections fixed and stained by the above methods offered an opportunity to study the position, etc., of mitochondria in relation to other cellular inclusions in similar cells. Considerable difficulty developed in the embedding of the tissue due to the presence of air in the tracheoles along the gut. This was overcome by extracting the air from the tissue by means of a suction flask before embedding. As the pressure in the flask was gradually increased the air was slowly removed from the tracheoles. The pressure was increased cautiously to insure no injury to the tissue.

All slides were observed with a monocular research microscope having a 12 X ocular and an oil immersion objective with a numerical aperature of 1.8, the combination of lenses giving a magnification of 1620. Cell drawings were made with aid of a camera lucida.

OBSERVATIONS AND DISCUSSION

MID-GUT

The inner layer of cells lining the mid-gut are epithelial cells of the columnar type, all elongated. The epithelium is folded. The cells are somewhat compressed along the basement membrane causing the nucleus to be of an oval shape. The free edges of the epithelial cells give the appearance of a brush border similar to the plateau as reported by Patterson (3). However, in the mid-gut epithelium as reported by this same author, there is no evidence of basal protoplasmic striations.

On the lumen side of the digestive epithelial cells are many granules. Certain cells show signs of rupturing their peripheral border. These cells are referred to as mature secretory cells. They have an abundance of secretion along the peripheral border causing a swelling of the cell in that region as shown in figs. 3 and 4. Those cells which appear to be degenerating in the epithelium and have completely lost all of their secretions slowly increase in size to maturity and pass through the same cycle. Evidence for the fact that these are still active living cells is that the nucleus appears to be normal at all stages, the nucleus being an indicator of the condition of the cell. Other secretory cells were observed which contained an abundance of very heavily stained granules. These cells were interpreted as one stage in the development of the mature secretory cell as shown in fig. 1. This type of cell was present in both the anterior and posterior of the gut.

The cells of the regenerative type were devoid of secretory granules. It appears that the secretion granules are present only in digestive cells. After the cell contents are discharged into the lumen they appear to degenerate. However, this is not the case as the cells in this state represent a stage in the functional cycle of the epithelial cells. This concept will be discussed later in this paper. There is no evidence of mitotic division among the large digestive cells. Regeneration appears to be entirely from the germinal centers. There appears to be very little difference in the cells of the anterior and posterior mid-gut. However, the granules are more prevalent in the anterior region signifying the secretory function of the mature epithelial cells. Those in the posterior region are more of an absorptive nature since they have fewer granules.

It is difficult to say precisely what is the exact type of epithelium lining the gut. It may be of two types, simple or pseudostratified columnar. With further investigation into the evolution of the germinal centers it should be possible to state definitely the specific type of epithelium composing the entire inner lining of the mid-gut. Division may be vertical with all the cells maintaining their attachment with the basement membrane, resulting in all simple columnar epithelium. Division in the germinal centers or nidi may be of a horizontal nature resulting in a pseudostratified type of cell as shown in figs. 1 and 2.

The free edges of the epithelial cells are described by some authors as being serrated. This characteristic was not clearly defined in all cases. The serrations were most evident in cells which were stained heavily. These edges may be due to the great pressure to which the

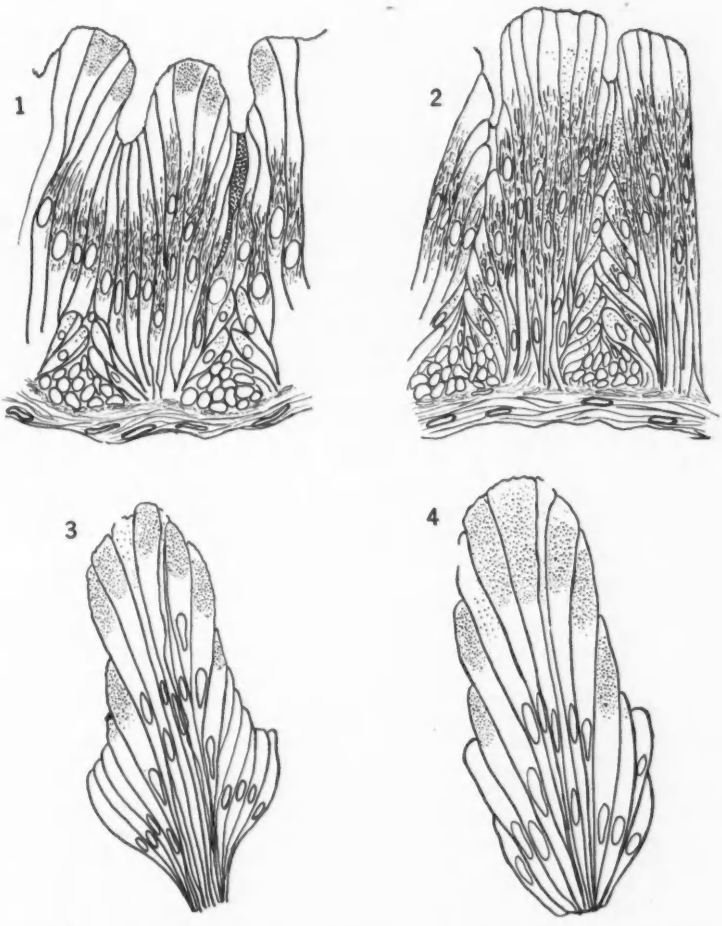

Fig. 1. A drawing of the midgut epithelium showing the position of the mitochondria, germinal centers, and secretory cells with large granules. Fig. 2. A drawing of the epithelium showing the mitochondria, and the formation of new cells. Fig. 3. A drawing of an epithelial crest showing the position of secretory granules and the ruptured free margins of several cells. Fig. 4. A drawing to show a group of active secretory cells indicated by the greater number of granules.

cell is exposed. Another interpretation is that the cells may be of the steriocilia type since no basal granules were evident.

Various regions along the epithelium in those cells of the digestive type exhibited an abundance of secretion within the cell along the lumen side. There were still other regions in which this characteristic was not evident. This phenomena may suggest periods of secretion alternate with periods of absorption in accordance with Gresson (1).

MITOCHONDRIA

Mitochondria are present in the epithelial cells of the mid-gut of the roach. They are in the form of rods, filaments and granules. They are distributed throughout the peripheral and middle regions of the cell; a few are on the basal side between the nucleus and the basement membranes as shown in fig. 2. There is no definite zonation of the mitochondria in these epithelial cells as reported by Woodruff, et al. In most of the young cells, which have not become digestive in their function, the mitochondria are scarce with the exception of a few granules at the periphery as shown in figs. 1 and 2. There is an abundance of large rods and filamentous mitochondria closely associated with the nucleus. On the peripheral side small granules appear around the globules of secretion at the edge of the cell next to the lumen as shown in figs. 3 and 4. Some authors identify these globules in the lumen of the cell as clumps of granular mitochondria. In a few of these cells the mitochondria are all long rods and no granules are present. The rods are located in the peripheral region of the cells. No secretion was noted in these cells.

In those cells which contain globules it is difficult to ascertain whether the globule is material absorbed or globules formed from the mitochondria. Supporting this later view is the fact that the globules are in close association with the granular mitochondria which are thought to be responsible for cellular secretion.

The rods are about one-half the length of the filaments. The granules vary considerably in size. The diameters of all three types of mitocondria are less than the identical types in hepatic cells of rats.

Secretory granules are present. Some authors, Gresson (1), identify spherical bodies with darkly stained borders located at the periphery of the cells. These structures are similar to secretory granules and are identified as developing secretory granules. In the author's observations these bodies were not identified. However, similar structures were observed in my observations on the mitochondria of hepatic cells of rats. These structures were also observed by other authors and were identified as spherical mitochondria functioning in the formation of glycogen, Noel (4). Patterson (3) also notes the presence of these spherical bodies in *Passalus cornutus*. However, in order to give definite identification and action to these bodies more evidence is needed.

In addition to the closely associated work of Gresson (1), and the work of Woodruff (5), on the mitochondria in the mid-gut of the grasshopper, he describes them as long filaments in the base of the secretory cells, shorter ones in the central region and very short rods or granules distally; therefore he suggests that in this cell there is a situation

comparable to the secretory cycle observed in the thyroid cells of the albino rat.

Observations by Shinoda (6), in *Bombyx* coincide somewhat with the author's accounts on the roach. Shinoda (6) states that the mitochondria are evenly distributed and the secretory granules are heaped at the distal end of the cell.

The work of Patterson (3) on *Passalus cornutus* does not agree with the account of Shinoda (6). She explains that this is due to the fact that the epithelium in *Bombyx* is entirely different from that in a coleopteran, for there it consists of two morphologically distinct cells, cylindrical and goblet cells.

Mitochondria occur in the very distal end of the cells in the roach and silkworm. Patterson (3) does not report the presence of mitochondria in the distal end in *Passalus*. She describes the mitochondria as rods, filaments and granules. She also describes spherical granules as having clear centers closely related to the Golgi apparatus in those sections fixed with osmic acid. The method of secretion is probably the same that occurs in Orthoptera where there are no true goblet cells but more information must be had before definite conclusion can be drawn concerning the relationship between the mitochondria and different secretory phases.

CONCLUSION

1. The paper notes observations of the mitochondria in the mid-gut epithelium of the roach, *Periplanta americana*.
2. There are two types of cells: secretory and absorptive.
3. Mitochondria consists of rods, filaments and granules.
4. Mitochondria persist chiefly as filaments and rods in the mature cells.
5. Granular mitochondria are present in the regenerative cells.
6. It is thought that the epithelial cells tend to go through a secretive and an absorptive cycle.
7. Mitochondria persist in the middle and peripheral regions of the cell; most abundant in the region of the nucleus.

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NOTES ON THE SYNONYMY AND CLASSIFICATION OF THE ENICOCEPHALIDAE

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In my recent "Classification of the Enicocephalidae" (ANNALS of the Entomological Society of America, 38 : 321, 1945) it was explained by footnote that no copy of Jeannel's recent monograph of this group of insects (Annales de la Société Entomologique de France, CX, p. 273, 1942) had reached this country because of the war. Through the kindness of Dr. R. I. Sailer I have now seen a copy of this important work. It is most unfortunate that this long neglected group should have been revised simultaneously by two authors, each working entirely independently. On the other hand some benefit has been derived from this procedure because Jeannel, although working without access to the Scandinavian, British, American, Pacific and Oriental types and other material which I studied, nevertheless, had access to types from continental collections which were inaccessible to me and some of which may now be destroyed.

The only straight synonyms created in my paper are *Pseudenicocephalus* Usinger, 1945, (type *Henicocephalus lewisi* Distant) which equals *Hoplitocoris* Jeannel, 1942, (type *Henicocephalus kenyensis* Jeannel) and *Ceratotrachelus* Usinger, 1945, (type *Henicocephalus cornifrons* Bergroth) which equals *Embolorrhinus* Jeannel, 1942, (type *Henicocephalus tuberculatus* Bergroth). In each of the above cases Jeannel's type was included in the list of species under my new genus.

Jeannel synonymizes *Aerochestes* Bergroth (type *Aenictopechys alluaudi* Jeannel) under Horvath's monotypic genus *Henschiella*. I had hesitated to do this because the unique character, "anterior coxal cavities closed," of Jeannel's species is not mentioned in Horvath's description and the type in the Museum at Budapest has not been re-examined to check this point. However, the two types agree in venation and other points so the synonymy is probably correct.

Perhaps the most outstanding contribution in Jeannel's work is his study of the genitalia of the Enicocephalidae. On the basis of his study of the male genitalia of the type of *Aenictopechys necopinatus* Breddin from the Museum of Hamburg, Jeannel has retained my subfamily Aenictophinae (spelled Aenictopechitae). He has also placed Enderlein's enigmatic *Phthirocoris antarcticus* which Bergroth assumed was based upon immature specimens. Jeannel's excellent illustrations of the male genitalia of the types from the Zoological Museum of the University of Berlin show that *Phthirocoris* is a unique genus of apterous Enicocephalidae based upon sexually mature but neoteinic specimens.

ARCHAEOPODAGRION BILOBATA, N. SP., FROM CENTRAL ECUADOR

(Odonata: Megapodagrioninae)

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This paper supplements Kennedy, 1939, "*Archaeopodagrion bicorne*, a very primitive dragonfly from Eastern Ecuador," Ann. Ent. Soc. Amer. 32: 32–43. The review of the pertinent literature attached to that paper will cover this article. *Bicorne* was given its own genus, *Archaeopodagrion*, because it showed characters which indicated relationships between two groups of genera of the South American Megapodagrioninae.

The present material is one male so rotten that it fell apart on opening the envelope; collected by Sr. Leopoldo Gómez Alonso recently in the U. S. Chinchona Survey. It was collected at Macas, Rio Upano, which stream is the headwater of the Rio Santiago in the military Province Santiago-Zamora of the "Oriente," the area of Ecuador east of the Andes. Gómez gives the elevation of Macas as 1050 meters. This area is south of Baños, east of which town on branches of the Rio Pastaza the genotype of *Archaeopodagrion bicorne* K. was taken. Both areas appear to be foot-hill streams in the extreme western end of the Amazon Basin.[1]

The name *bilobata* parallels *bicorne* and is in reference to the more deeply split posterior lobe of the prothorax (fig. 9) than in *bicorne*. The single specimen (♂) is at present in the author's collection.

Holotype male: Length,[2] abdomen, 35 mm.; hind wing, 25 mm.

Color. Fig. 10. Labrum medium blue, edged with black below, ante-clypeus pale (greenish yellow?) edged with black above which is continuous with the horizontal surface of the post-clypeus. Bases of jaws, lower three-fourths of genae pale greenish yellow. Frons, vertex, occiput (entire top of head and antennae) black; under surface of head entirely black. Labium (except palps black) and bases of maxillae pale. Maxillary palps black.

Eyes in the dried rotten specimen uniformly dark with perhaps a slight greenish tint.

Prothorax. Fig. 5. Anterior lobe black; middle and posterior lobes broadly black above; lower half of side of middle lobe pale, sharply defined from the black above, the pale area continued on the posterior lobe covering its lower half but not sharply defined from the black above. Coxa and trochanter pale except for a brown cross-line at apex of trochanter (fig. 3).

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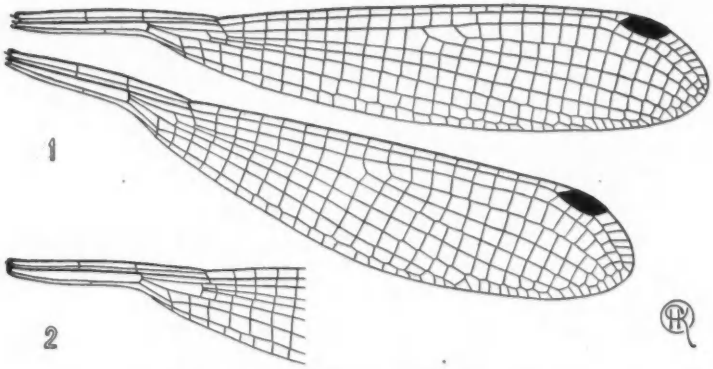
[1]Brown, F. Martin, 1941. "A Gazetteer of Entomological Stations in Ecuador." Ann. Ent. Soc. Amer. 34(4): 809–851, 10 maps.

[2]The measurements of *bicorne* K. are, male abd., 35 mm.; hind wing, 25 mm. female, abd., 31 mm.; hind wing, 27 mm. These were omitted in the origina description, 1939.

Pterothorax with mesostigmal lamina and antealar sinus black. The black continued down, covering the mesinfraepisternum except for its pale lower posterior corner. A broad black middorsal stripe covering the dorsal or inner halves of the mesepisterna. This stripe slightly narrowed before the antealar carinae, the triangular area of which is black. The black of the mesinfraepisternum continued caudad as a vague, dark area covering the mesepimeron (fig. 14). (The upper half along the humeral suture may be pale (blue?) in life.) A similar vague or slightly darker stripe covering the upper third and anterior edge of the metinfraepisternum and continued as a dark stripe covering the lower (below spiracle) two-fifths of the metepisternum. Side of thorax and coxae otherwise pale with a distinct pale bluish tinge shading into a creamy yellow on the inferior surface. Sternites, II and III, black. Coxae pale. Trochanters with an apical

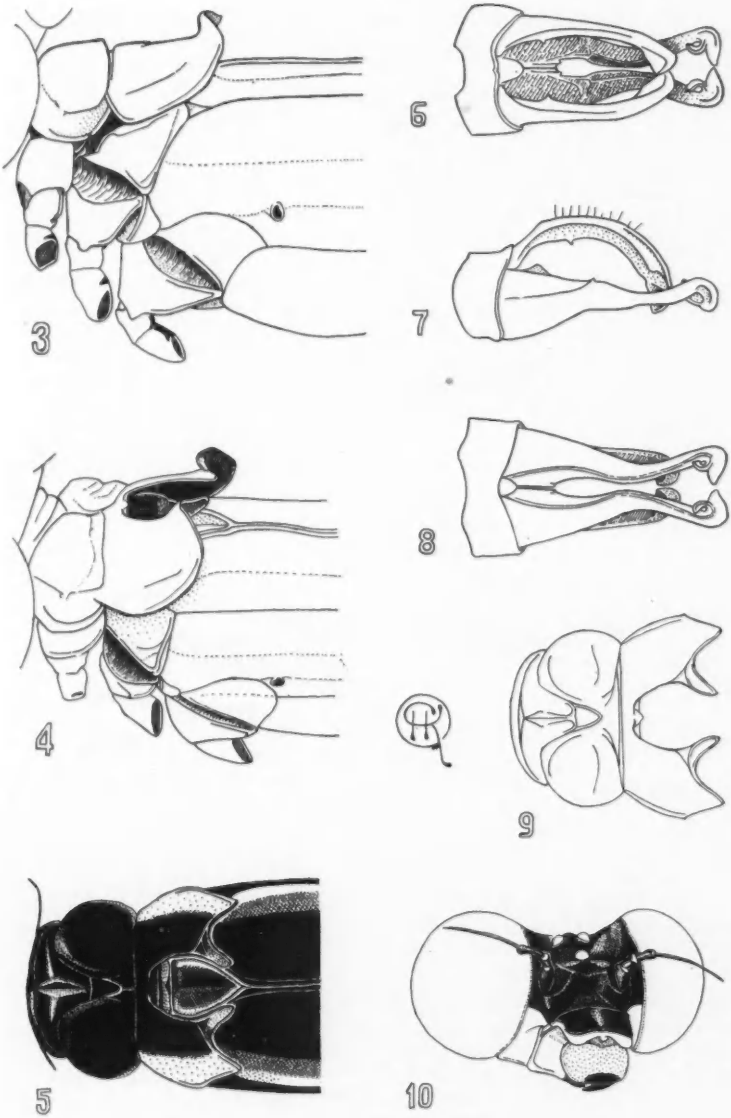


FIGS. 1 and 2. *Archaeopodagrion bilobata* n. sp.

1. Left forewings reversed. 2. Base of right forewing showing abnormal origins of Rs and M_3.

dorsal black spot (fig. 3). Femora pale with a broad dorsal black stripe merging into a black "knee." Tibiae pale except extreme tip dark. Tarsi dark. All spines black. Wings with stigmas black and a very diffuse yellow, smoky tint from stigma to apex.

Abdomen with sides of seg. 1 pale (blue?); a narrow apical ring and dorsum black. Seg. 2 black: lower half of side pale (blue?), pale area occupying the middle three-fifths of the side, the pale extending to the inferior-posterior angle. Sternal parts of segs. 1 and 2 pale; the walls of the genital fossa and anterior hamules broadly edged with black. Penis shaft and seminal vesicle black. Segs. 3–7 black with a well-developed anterior pale ring divided on the dorsal line by black. The lower posterior angle of the anterior pale ring continued caudad in a slender triangular pale area one-third to one-fourth the length of the segment. Segs. 8–10 black with a suggestion of pale along the anterior

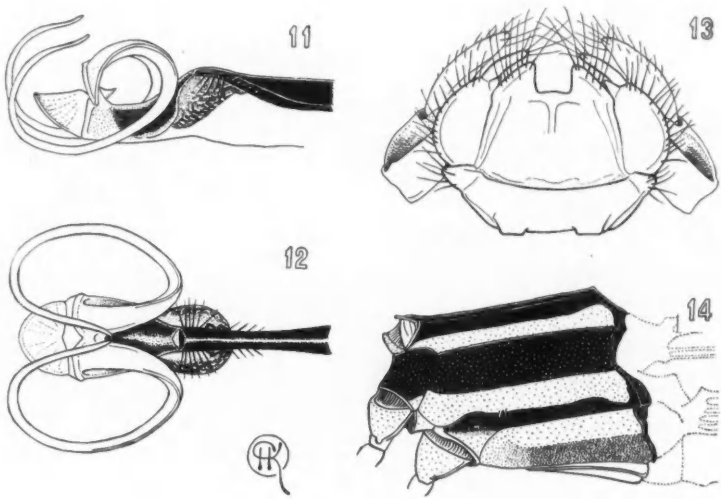


FIGS. 3–10. *Archaeopodagrion bilobata* n. sp.
3–5 and 9. Views of the bilobed prothorax. 6–8. Male appendages. 10. Face.

half of the lower edge of the side. Sterna of 3–10 black. Both superior and inferior appendages black. ***Bilobata*** is a distinctly darker colored species than ***bicorne***, particularly in color of the abdomen.

Structure: Head.—Labium with a quadrangular apical notch as deep as that in ***bicorne*** (fig. 13). Frons broadly rounded between vertical and horizontal surfaces (no transverse frontal keel as in some Heteragrions). Fig. 10.

Prothorax.—(Compare with figs. 5–7 of ***bicorne***, 1939.) Middle lobe with a sharply and deeply impressed dorsal area (figs. 4, 5, 9). Posterior lobe enormously developed into a divided apron either half



FIGS. 11–14. *Archaeopodagrion bilobata* n. sp.

11, 12. Penis. 13. Labium (and maxillae) showing the quadrangular apical notch as in Heteragrion.

14. Probable colors of pterothorax. (The pale humeral stripe may extend over upper half of mesepimeron, while its upper half may be infuscated as shown in fig. 5.)

of which spreads over a "shoulder" of the pterothorax. Viewed from above the posterior edge of each lobe has two angles, an outer angle over the humeral suture slightly less than 90°, an inner blade-like angle lying over the diagonal posterior rim of the mesostigmal lamina (fig. 5). Viewed from the side the base of the inner blade-like angle is the apex of one of the two horns projecting vertically. The outer angle of each half of the apron appears more rounded, the inner blade-like lobe is hidden behind its base except for perhaps its tip in some views (fig. 3).

Thus from its side the prothorax looks very much like that in ***bicorne***, but viewed from above the two horns disappear and the inner knife-like blade and the outer angle appear.

Pterothorax with a simple mesostigmal lamina as in ***bicornis;*** and of the general form and size of that in ***bicorne***. Legs similar to those in ***bicorne*** (1939, figs. 3 and 4).

Wings (fig. 1), length from base to nodus 3.5 times in total length. Greatest width in length, f. wg. 5.6 times, h. wg. 5.2 times; petioled to end of basal third of quadrangle. Stigma is long, subtending 2.5 R_1 cells, wider than in ***bicorne***, width 3 times in greatest diagonal length; ends distinctly oblique (45°); a light-weight brace vein. Antenodals 2; arculus distinctly beyond second antenodal in forewing, barely beyond second antenodal in hindwing. Post-nodals 20 in forewing, 17 in hindwing. M_2 arises halfway between p. n. 9 and 10 in forewing, at 8 in hindwing. M_{1a} arises just beyond postnodal 11 in forewing and at postnodal 9 in hindwing. Rs arises at subnodus in both wings; M_3 arises in both wings basad of subnodus the length of one middle costal cell. All veins smooth except tips of R_1 beyond stigma; M_1, M_{1a}, and outer halves of M_4 and Cu_2. In both wings 2 post-quadrangular M_4 cells, quadrangle long and narrow, widening distally, its outer side oblique. Forewing, the outer end of quadrangle 2.3 times in anterior side, 3.4 times in the posterior side; inner end 5.2 times in length of anterior side. Hindwing, quadrangle with outer side 3 times in anterior side, 3.5 times in posterior side; inner end 6.8 times into anterior side. Apex of Cu_2, f. wg., at level of end of fourth M_{1a} cell. Apex of Cu_2, h. wg., at a level of 3rd costal cell beyond origin of M_{1a}. No extra sectors other than M_{1a}. Anal crossing, forewing, at level of apex of basal third of distance between antenodal 1 and 2; at the level of end of basal fourth of distance between antenodal 1 and 2 in hindwing. Fig. 2 shows the abnormal origins of Rs and M_3 in the right forewing.

Abdomen moderately slender, depth of middle of seg. 4, slightly less than depth of seg. 10. The latter seg. twice as deep as long (fig. 7).

Penis, figs. 11, 12, with a distinct but small inner lobe (fig. 11) of the shape of that in ***Megapodagrion***. The slender apical lobes are slightly more robust than in ***bicorne*** (1939, figs. 12, 13) and have the notch separating them (fig. 12), deeper than that in ***bicorne***, thus more like ***Megapodagrion***. The erectile terminal flap is shown erected by a drop of hot water and is probably little different from that in ***bicorne*** (1939, figs. 12, 13), where it is dried. When fully moist the terminal lobes are round in cross-section and less ribbon-like. A single row of shaft spines.

Apical appendages long; superiors 3.6 times as long as seg. 10; inferiors 4.6 times as long as seg. 10. Dorsal view: superiors slightly curved ectad from base to apex, the two tips slightly overlapping; forcipate, apical 6th widening to a truncate tip, the inner edge of which widened portion is a knife edge; a small triangular spine on the inner profile at slightly more than one-fourth the distance from base to apex. Inferior appendages longer than superiors by one-fourth the length of the latter; the two fused from base to end of basal fourth of length, slender, approaching each other at their outer three-fifths, then widening

to apex which is turned entad at right angles to shaft of appendage and which ends in an acute point; at the inner base of this turned-in apex is a minute blade-like branch which curves back and up from the main tip. A minute dorsal spine or ridge on dorsal side of mid-length of interior not visible when viewed from above.

Side view: The superiors long, narrow, gently arched through 120° of circle; narrower at base than in outer two-thirds; a minute internal spine visible at end of basal third. Inferiors with base 3 times into length. A minute spine (end of a sharp cross ridge?) at apex of basal three-sevenths. Apices of inferior turned down in a smoothly rounded curve covering the apical half of the inner apical branch which curves up.

Remarks: The species ***bilobata*** fits exactly into the Genus ***Archaeopodagrion*** Kennedy as described for the species ***bicorne***, 1939. We care to make no changes in generic characterization with the discovery of the second species. No other characters appear in the second species which would suggest that *Archaeopodagrion* is other than a very simply veined Megapodagrionine genus.

BRAZIL, ORCHID OF THE TROPICS, by MULFORD and RACINE FOSTER. xi+ 314 pp., many plates, both half-tone and colored. The Jacques Cattell Press, Lancaster, Pa., 1945. Price $3.00.

This interesting book is essentially a tale of travel and botanical exploration, with bromeliads as the major goal, but whether or not one knows a bromeliad from a cabbage he will find it good reading. It is replete with observations on the nature of the country, conditions of travel and the peculiar problems of collecting epiphytic plants. A lowly insect chaser does not envy the feats of climbing involved, nor the size and weight of the specimens secured, but as he reads he does wonder what that upper world of the jungle might contain for him.

Mr. and Mrs. Foster landed at Rio de Janeiro, worked north into Bahia where they collected along the Rio de Contas. The little coastal state of Espirito Santo is treated next, then Rio and São Paulo, followed by several chapters devoted to Parana. The remainder of the book treats a second trip taken in 1940, chiefly in São Paulo, Minas Geraes and Matto Grosso. Thus the area covered is the central coastal portion of the country and inland into Matto Grosso, certainly a representative section of this rich and varied land.

Many years ago the reviewer decided that his money would buy much more South American material from resident collectors than it would secure if expended on a collecting trip. He had not then read such an account of collecting on that fabulously rich continent! The Fosters present such a fascinating account of their experiences that they awaken again the desire to see insects on the wing which are now known only as dried specimens, to pry into the secrets of strange territory, to seek rarities where they live. They tempt their scientific readers while they entertain them. By all means read their book if you want either result, and if you are tempted to the point of doing as they did, the tale of their experiences will also prepare you for the conditions of such a trip. It must involve hard work and primitive living conditions for the best results, but it must also provide lasting memories which one must envy these fortunate botanists.

—A. W. L.

ON THE CHILOPODS OF ALASKA

RALPH V. CHAMBERLIN,
University of Utah

In this paper is summarized what is now known of the chilopods of Alaska. It is occasioned by the coming into my hands of the material collected at several points in the territory, more particularly in the Watanuska Valley, by Dr. Joseph C. Chamberlin during 1943, 1944, and 1945. This material has increased substantially our knowledge of the centiped fauna of the region. Of the twenty-two forms here listed twelve species are described as new, among these species being representatives of three new genera and one new subgenus. Types of new species as well as all other specimens are retained at present in the author's collection at the University of Utah.

LIST OF SPECIES

Escaryus albus Cook
Escaryus delus, new species
Escaryus paucipes, new species
Geophilus alaskanus Cook
Geophilus ethopus Chamberlin
Pachymerium ferrugineum (C. L. Koch)
Synthophilus boreus, new genus and species
Cheiletha alaska, new genus and species
Linotaenia chionophila (Wood)
Lamyctes fulvicornis (Meinert)
Oabius alaskanus, new species
Oabius adjacens, new species
Oabius arktaus, new species
Paobius boreus Chamberlin
Monotarsobius tricalcaratus Attems
Ezembius stejnegeri (Bollman)
Nadabius caducipes, new species
Alaskobius josephus, new genus and species
Alaskobius adlatus, new species
Alaskobius parvior, new species
Ethopolys integer alaskanua, Chamberlin
Bothropolys (*Oligopolys*) *ethus*, new subgenus and species

Order **GEOPHILIDA**

Family **Schendylidae**

Escaryus albus Cook

Escaryus albus Cook, Harriman Alaska Expedition, 1904, VIII, p. 77.

Known only from the types, two specimens taken on St. Paul Island in the Pribilof group in 1897 by T. Kincaid.

Escaryus delus, n. sp.

Dorsum yellow, of orange tinge at caudal end and more especially over anterior portion, the head a deeper orange.

The cephalic plate only slightly longer than broad anteriorly, narrowing conspicuously caudad. Frontal plate not discrete. (See fig. 1).

On the clypeus in front of the labrum two large non-areolate fields, separated by a narrow areolate median stripe. Across anterior border of clypeus a transverse series of twelve setae; farther caudad two setae on median areolate stripe.

Labrum at middle moderately embayed; the teeth about twenty-one in number, stout and of moderate length, not distally prolonged in slender tips as they are in *sibiricus*. See further fig. 2. Syncoxite of first maxillae without lappets; palpus biarticulate, with a long lappet, the terminal joint also prolonged into a membranous tip. Mandibles with teeth in three distinct blocks.

Basal plate overlapped anteriorly by the cephalic; as wide, posteriorly as the cephalic plate. (fig. 1). Prehensors large, well exposed in dorsal view; claws when closed not surpassing anterior margin of head; prosternum broad, without chitinous lines and unarmed anteriorly; joints of prehensors short, all unarmed.

Dorsal plates bisulcate.

First spiracles much larger than the second, circular.

Sternites with a shallow basin-like depression in middle region at the bottom of which is a longitudinal sulcus which does not reach anterior or posterior margins.

Ventral pores not detected.

Last ventral plate relatively long and narrow, somewhat narrower than the penult sternite is posteriorly; with its sides nearly parallel. Coxal pores small and numerous.

Anal pores present, small.

Anal legs of male conspicuously inflated, its thin claw distinctly developed, but small.

Pairs of legs in male holotype, 47; in female allotype, 45.

Length, 40 mm.

Locality.—Alaska: Circle City, June 21, 1945. One male taken by Drs. J. C. Chamberlin and Jeanne Johnson. Fairbanks: One female taken September 22, 1943.

This species may be placed with reference to the other species known from the Alaskan and Siberian regions by means of the following key:

KEY TO SPECIES OF ESCARYUS

1. Claw of anal legs very small in comparison with those of other legs.....2
   Claw of anal legs of normal size, as large as those of other legs...**E. albus** Cook
2. Anal pores present (Alaska).....**E. delus** n. sp.
   Anal pores absent.....3
3. Pairs of legs 33 (Alaska).....**E. paucipes** n. sp.
   Pairs of legs 49–51 (Asia).....4
4. Syncoxite of first maxillae with long membranous lappets; lateral teeth of labrum with long, slender tips.....**sibiricus** Cook
   Syncoxite of first maxillae without membranous lappets, all teeth of labrum short, and stout.....**japonicus** Attems

Escaryus paucipes, n. sp.

Cephalic plate of form shown in fig. 3. Antennae gently-attenuated distad.

Clypeus without non-areolate fields in front of the labrum. Labrum simple, not divided, the median arc with twelve stout teeth as shown in fig. 4.

Dental plate of mandible divided into three blocks of 3, 4, and 5, teeth respectively, the first (distal) tooth of each block much larger than the others. First maxillae without membranous lappets.

Basal plate covered anteriorly, short. Prosternum without chitinous lines. Claws of prehensors when closed not passing anterior margin of head; femuroid short, with a tooth at distal end; the second joint with a slight pale tubercle and the third with a more pronounced paler tooth; a dark tooth at base of the claw.

Spiracles all circular, the first much larger than the second, the second intermediate. Dorsal plate bisulcate, but the sulci not sharply defined.

Last ventral plate trapeziform. Coxal pores in holotype eight on each side, these all on lower surface.

Anal legs with claw considerably shorter than those of preceding legs.

No anal pores detected.

Pairs of legs, 33.

Length, about 14 mm.

Locality.—Alaska: Haines. One male taken August 23, 1945.

Readily distinguished among known species by the small number of legs, the lack of non-areolate clypeal areas and the structure of the labrum, etc.

Family **Geophilidae**

Geophilus alaskanus Cook

Geophilus alaskanus Cook, Harriman, Alaska. Expedition, VIII, 1904, p. 75.
Geophilus alaskanus Chamberlin, 1919, Canad. Arctic Exped., Vol. 3, p. 15H.

The male holotype was taken at Sitka in June, 1899, and it has also been taken on Forrester Island. (R. and H. Heath coll.)

Geophilus ethopus Chamberlin

Geophilus ethopus Chamberlin, 1920, Proc. Biol. Soc. Wash., Vol. 33, p. 43.

The male holotype was taken at Iditarod in June, 1918, by A. H. Twitchell.

Pachymerium ferrugineum (C. L. Koch)

Geophilus ferrugineus C. L. Koch, 1835, Deutschlands Crust, Myr. u. Arachniden, fasc 3, t. 2.
Pachymerium ferrugineum C. L. Koch, 1847, in Koch-Panzer, Krit. Revision d. Insekten-fauna Deutschlands, Vol. 3, p. 187.
Mecistocephalus attenuatus Cook (nec Say), 1904, Harriman Alaska Expedition, VIII, p. 74.

Recorded in the Harriman report from Yakutat Bay (a female with young) and from St. Paul Island. (One specimen taken by Kincaid in 1897.)

Genus **Synthophilus,** new

Cephalic plate but little longer than broad, typically lacking a frontal suture. Basal plate broad. Labrum with lateral divisions pectinate, the median more strongly dentate, with the free margins and their teeth directed ventrad. First maxillae lacking lappets. Coxae of second maxillae broadly joined at middle. Prehensors short lacking chitinous lines; each claw typically with a tooth toward base on inner side. Dorsal plates bisulcate. Ventral pores absent. Anal legs with tarsus biarticulate ending in a claw. Coxopleurae of last legs with several pores on ventral surface.

Generotype: *Synthophilus boreus*, new species.

Differing from *Brachygeophilus* in the ventrally directed teeth of the labrum and in lacking lappets from both joints of the first maxillae.

Synthophilus boreus, n. sp.

Cephalic plate only a little longer than broad (7 : 6), the caudal margin straight, the anterior margin very obtusely angular; without frontal suture (fig. 5). The clypeal region crossed by a fold presenting a sharply defined posterior margin from the convex middle portion of which several setae project caudad. Last article of antennae equal in length to the two preceding taken together.

The labrum with median division presenting about ten ventrally directed teeth, of which the two median are darker and more strongly sclerotized, overlapped on anterior side of each end by the lateral piece which is pectinate, with the pectinae also directed nearly ventrad. See further fig. 6. First maxillae with inner lobe bearing three setae in a longitudinal series; palpus biarticulate, the second article also bearing three ventral setae in longitudinal series. Second maxillae with coxae broadly united with median region membranous, less sclerotized; claw of palpus straight over basal and median region, curved only apically as shown in fig. 7.

Basal plate caudally as wide as the cephalic plate, comparatively long. Prebasal plate may be slightly exposed. (See fig. 1). Claws of prehensors each with a small tooth at base, the other articles unarmed; prosternum narrowly and deeply incised at middle; no chitinous lines.

Sternites with three sharply defined longitudinal sulci, a median and one on each side.

Last ventral plate broad, with the caudal margin straight. About six small coxal pores on each side.

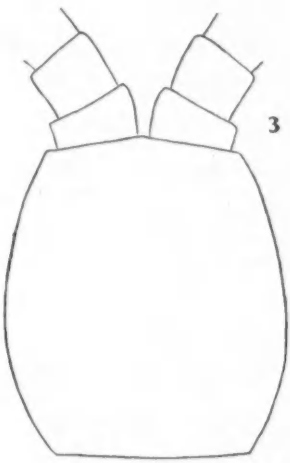
Length, about 21 mm.

Pairs of legs, 45–47.

Locality.—Alaska: Juneau, (Type Loc.), four specimens taken April 28–29, 1945; Haines, three specimens taken August 20–25, 1945, the types being taken August 22.

EXPLANATION OF PLATE I

Escaryus delus, new species. Fig. 1. Anterior end, dorsal view. Fig. 2. Labrum. *Escaryus paucipes*, new species. Fig. 3. Head, dorsal view. Fig. 4. Labrum. *Synthopihlus boreus*, new genus and species. Fig. 5. Head and basal plate, dorsal view.



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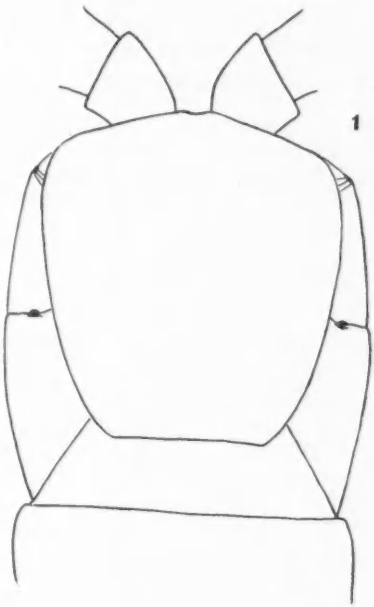

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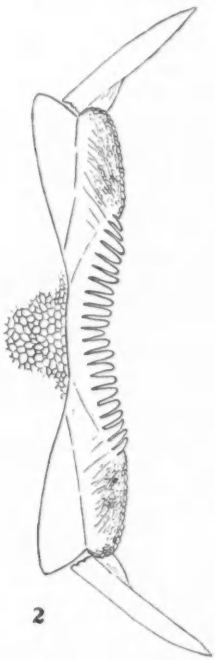

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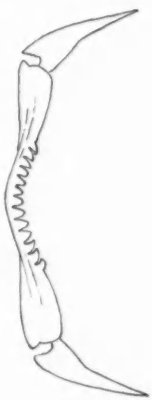

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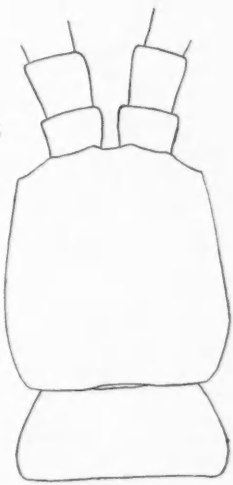


5

Family **Chilenophilidae**

Arctogeophilus glacialis Attems

Geophilus (*Arctogeophilus*) *glacialis* Attems, 1909, Ark. Zool., Vol. 5, nr. 3, p. 23, t 1, f. 1–4.
Cryophilus alaskanus Chamberlin, 1919, Rept. Can. Arctic Exped., Vol. III, p. 18H, figs. 1–5.

Locality.—College, near Fairbanks. One specimen taken by J. C. Chamberlin, June 26, 1945.

Previously recorded by Attems from Port Clarence and by Chamberlin from Nome.

Differences pointed out by the writer for *C. alaskanus* are apparently due to inaccuracies in Attems' original description and figures for *A. glacialis*.

Arctogeophilus melanonotus (Wood)

Mecistocephalus melanonotus Wood, 1862, Jour. Phila. Acad., Vol. V, p. 41.
Mecistocephalus limatus Wood, 1862, *ibid*., p. 41.
Gnathomerium melanonotum, Chamberlin, 1911, Pomona College Jour. Ent. and Zool., Vol. 3, p. 661.

This species common in California and northward to British Columbia, off the coast of which it also occurs on Forrester Island, where it was collected by Ronald and Prof. H. Heath.

Genus **Chelietha,** new

A Chilenophelid genus apparently most closely related to the Australian *Queenslandophilus*. From the latter it differs in having the first maxillae with two pairs of membranous lappets instead of one, and in having the coxae of the second maxillae united only by a narrow, finely areolate isthmus instead of being fully separated.

Lateral pieces of labrum meeting at middle line in front of the median piece, fringed or toothed both at middle and laterally with long seta-like processes directed more or less caudad and typically not in a single series.

Prehensors large, toothed within, exposed from above both laterally and anteriorly.

Sternites lacking ventral pores. Last ventral plate of intermediate width. Coxal pores small and numerous. Anal legs with well developed claws.

Generotype: *Cheiletha alaska*, new species.

In addition to the genotype, includes *C. viridicans* (Attems), the latter occurring in Japan.

Cheiletha alaska, n. sp.

Cephalic plate much longer than broad (65 : 44); broadest a little in front of the middle, from where gently narrowing cephalad and conspicuously narrowing caudad, with caudal corners widely rounded. (fig. 8). Frontal suture indicated by a clear light line. A single, very finely areolate clypeal area. A transverse series of four setae each side of the clypeal area and two setae in line with its anterior margin. Last article of antennae about equal to the two preceding taken together.

Labrum with caudally, or in part ventrally, directed long setae at middle and inner part of sides, those at middle not in a single series; true teeth absent. (fig. 9). First maxillae each with two membranous lappets, one borne on coxal division and one on first joint of palpus. Coxae of second maxillae connected by a narrow, less sclerotized isthmus which is finely areolate.

Basal plate large, broader across base than the cephalic plate. Prebasal plate not exposed. Prehensors exposed in dorsal view, the claws when closed extending well beyond from margin of head, attaining or somewhat surpassing distal end of first antennal joint. Prosternum long, unarmed anteriorly, and without chitinous lines. Femuroid armed distally with a black, rounded tooth, the other two joints and the claw at base each armed with a smaller rounded tooth or nodule.

First spiracle large, a little vertically elongate or subelliptic, much exceeding the second in size.

Sternites without ventral pores. Anterior plates without anterior pits and posterior processes.

Last ventral plate moderately wide, only a little narrowed caudad. Coxal pores small and fairly numerous, arranged chiefly along the ventral and dorsal plates. Anal pores present, small.

Last legs with claw well developed.

Pairs of legs, 45–47.

Length, 25 mm.

Locality.—Alaska: Juneau. Eight specimens taken April 28–29, 1945, by J. C. Chamberlin.

Evidently very closely related to *C. viridicans* (Attems) of Japan but, according to Attems' description and figure, differing strikingly in having the labrum fringed with very long, seta-like teeth instead of being "am Rande *kraftig* und kurz gezähnte."

Family **Linotaeniidae**

Linotaenia chionophila (Wood)

Strigamia chionophila Wood, 1862, Jour. Phila. Acad. Sci., p. 50.
Scolioplanes chionophilus Meinert, 1885, Proc. Am. Phil. Soc., Vol. 21, p. 223.
Linotaenia chionophila Bollman, 1893, Bull. U. S. Nat. Mus., No. 46, p. 123; also Cook, 1898, The Fur and Fur-Seal Islands of the North Pacific Ocean, p. 4, p. 350.
Tomataenia chionophilia Cook, 1904, Harriman Alaska Exped., Vol. 8, p. 73.
Tomotaenia (Scolioplanes) chionophila Wood, Attems, Arkiv Zool., Vol. 5, p. 9.
Linotaenia chionophila Chamberlin, 1919, Canad. Arctic Exped., Vol. 8, p. 15H.

A species recorded from Sitka, Unalaska, Lowe Inlet, and on Pribilof, Aleutian, Kardiak, Boranof, Popof, Bering, Cooper, and Forrester Islands. The J. C. Chamberlin collection includes specimens from Juneau (April 28–29, 1945) and from Haines (August 25, 1945). It also ranges across Canada and the northern United States and is very close, at least, to the common European *L. acuminata* (Leach).

Order **LITHOBIIDA**

Family **Henicopidae**

Lamyctes fulvicornis Meinert

Lamyctes fulvicornis Meinert, 1842, Naturhistorisk Tidsskrift, 3rd ser., Vol. 5, p. 267.
Lamcytes fulvicornis Chamberlin 1912, Bull. Mus. Comp. Zool., Harvard University, Vol. 57, p 7.

About a dozen specimens of this species, widespread in Europe and North America, were taken by J. C. Chamberlin at Haines, August 25, 1945.

A single specimen was also taken at Fairbanks on September 22, 1943.

Oabius alaskanus, n. sp.

Yellow to pale chestnut, the antennae darker than the legs.

Antennae short. Ocelli in three series, the single ocellus not separated, moderately larger than the others; e. g., 1÷4, 4, 2.

Prosternal teeth 2÷2, with the median incision narrowly V-shaped and acute at the bottom.

Ventral spines of first legs, 0, 0, 1, 2, 1. Third joint of all legs dorsally armed. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 1, 0; claws 2. Ventral spines of anal legs, 0, 1, 3, 2, 0, or occasionally 0, 1, 3, 3, 0, on one side; dorsal spines, 1, 0, 3, 0, 0, claw single. Last coxae laterally armed, or rarely with no lateral spine.

Claw of female genital forceps tripartite; basal spines 2÷2, these proximally nearly parallel-sided, the outer one of each pair apically with two or three teeth or points.

Length, about 9 mm.

Locality.—Alaska: Haines. Thirteen specimens taken August 25, and numerous specimens August 23, 1945. Richardson Highway, 10 miles north of Rapids. One, June 16, 1945. Homer. About fifteen specimens taken July 28, 1945. Juneau. Twelve specimens taken April 28–29, 1945. Matanuska. One female, probably this species, taken May 7, 1945.

In the dorsal spining of the anal legs agreeing with *O. tabiphilus* Chamberlin, which occurs in California, but differing in having the dorsal spines of the penult legs 1, 0, 3, 1, 0, instead of 1, 0, 3, 1, 1, and in having no lateral spine on the penult coxae.

Oabius adjacens, n. sp.

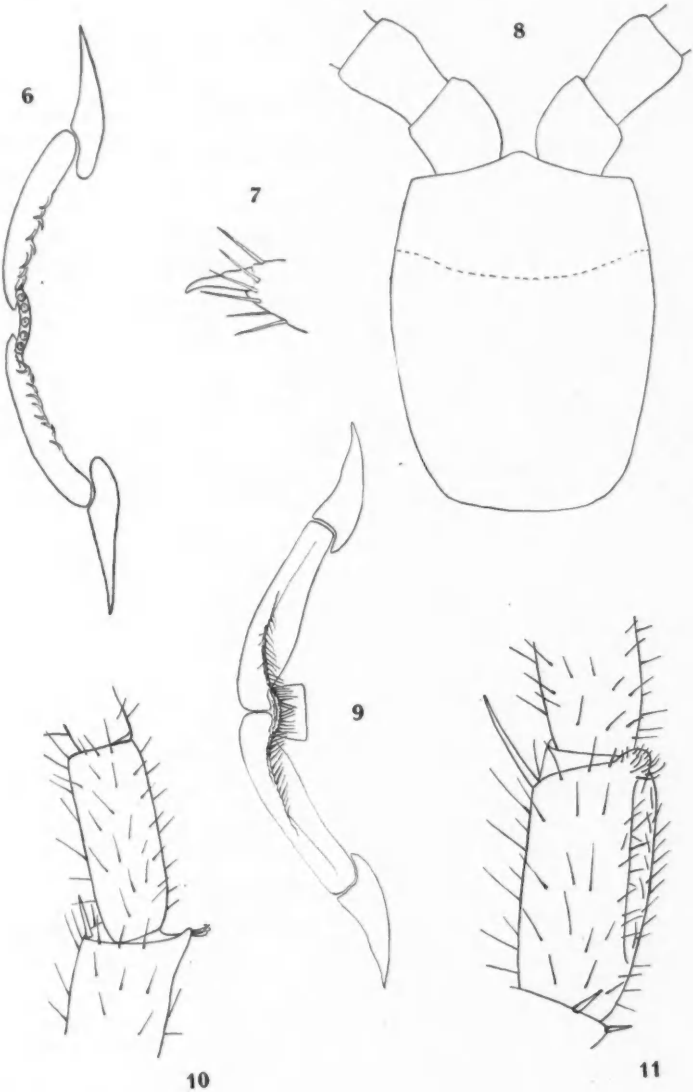
A darker, more brownish form than *O. alaskanus* and also more robust.

Antennae short. Ocelli in three series, the single ocellus contiguous, somewhat smaller than the first one of the top row; e. g., 1÷4, 3, 3. Prosternal teeth 2÷2; the median incision V-shaped, less acute than in *O. alaskanus*.

Ventral spines of first legs 0, 0, 1, 3, 1. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 1, 1, claws 2. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claw single. Last two pairs of coxae laterally armed.

EXPLANATION OF PLATE II

Synthophilus boreus, new species (cont.) Fig. 6. Labrum. Fig. 7. Tip of palpus of second maxilla. *Cheiletha alaska*, new genus and species. Fig. 8. Head, dorsal view. Fig. 9. Labrum. *Alaskobius josephus*, new genus and species. Fig. 10. Portion of anal leg, mesal view, showing form of process of fourth joint. *Alaskobius adlatus*, new species. Fig. 11. Portion of anal leg, mesal view, showing process of fourth joint.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Claw of female genital forceps tripartite; basal spines 2÷2, essentially as in *alaskanus*.

Length, about 9 mm.

Locality.—Alaska: Juneau. Seventeen specimens taken April 28–29, 1945.

This species is also close to *O. tabiphilus* with which it agrees in the spining of the anal legs and in having the last two pairs of coxae laterally armed. It differs, e. g., in having the fifth joint of legs following the first armed with a single dorsal spine instead of with two.

Oabius arktaus, n. sp.

A notably smaller species than the others herein listed.

Color yellow, with slight orange tinge, the pigment more dense in head and antennae.

Antennae short; articles short and very short. Ocelli few, 1÷2, 2, or 1÷2, 3.

Prosternal teeth small and pale, 2÷2.

Ventral spines of first legs, 0, 0, 0, 0, 1. Fifth joint of legs with a single dorsal spine. Ventral spines of penult legs, 0, 1, 3, 3, 2; dorsal, 1, 0, 3, 1, 0. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claw single. Anal coxae laterally armed.

Claw of female gonopods tripartite. Basal spines 2÷2, proportionately long, cylindrical to the short, acuminate apical portion.

Length, 4–5 mm.

Locality.—Fairbanks. Two males and a female taken September 21–22, 1943.

Paobius boreus Chamberlin

Paobius boreus Chamberlin, 1916, Bull. Mus. Comp. Zool. Harvard. Vol. 57, No. 4, p. 163, pl. 3, figs. 7–9, pl. 4, figs. 1–3.

This species, the genotype of *Paobius*, was based upon numerous specimens taken on Forrester Island in 1913 by H. and R. W. Heath.

Monotarsobius tricalcaratus Attems

Monotarsobius tricalcaratus, Attems, 1909, Arkiv Zool., Vol. 5, No. 3, p. 20, pl. 1 fig. 5.

The female holotype of this form was taken by the Vega Expedition at Port Clarence.

Ezembius stejnegeri (Bollman)

Lithobius stejnegeri Bollman, 1893, Bull. U. S. Nat. Mus., Vol. 46, p. 129, Cook, 1904, Harriman Alaska. Exped., Vol. 8, p. 71.
Monotarsobius arcticus Attems, 1909, Arkiv Zool., Vol. 8, No. 3, p. 19.
Lithobius (*Archilithobius*) *haasei* Attems, 1909, *op. cit.*, p. 22.
Lithobius stejnegeri Chamberlin, 1911, Canad. Ent., p. 260.
Ezembius stejnegeri Chamberlin, 1919, Canad. Arctic Exped., Vol. 3, p. 19H.
Ezembius stejnegeri Chamberlin, 1923, North American Fauna, No. 46, U. S. Bureau of Biological Survey, p. 241.

Apparently common in the Alaska region. It has previously been recorded from St. Paul Island, St. George Island, Bering Island (type locality), Copper Island, Popof Island, and other neighboring islands.

It was also taken at Teller in 1913 by Johansen as recorded by the author in the report on the Canad. Arctic Exped. (P. 19H.)

In the J. C. Chamberlin collection there are specimens from Palmer (May 1, 1945), Butte Area in the Matnuska Valley (May 18, 1945), and Matanuska (May 7, 1945).

Nadabius caducipes, n. sp.

Pale orange yellow in general color; the antennae orange, posterior legs lighter orange, the other legs yellow.

Antennae very short, composed of the usual twenty articles. Ocelli in two series, e. g., 1÷3, 3; the single ocellus paler and much smaller than the first of the upper series, the middle ocellus of bottom series smaller than the others.

Prosternal teeth pale, 2÷2, the median incision shallow, acutely V-shaped.

No ventral spines on first legs, the dorsal spine 0, 0, 0, 0, 1. Ventral spines of penult legs 0, 1, 3, 3, (2), 1; dorsal spines 1, 0, 2, 1, 0; claw armed. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 1, 0; claw armed. Dorsal spines of thirteenth legs, 1, 0, 2, 1, 1; of the twelfth, 0, 0, 1, 1, 1. None of the coxae laterally armed.

Process of fifth joint of anal legs of male of usual general form but low; located toward mesal edge. The penult legs of male also conspicuously modified, having on the fifth joint along dorsocaudal face a ridge or low hill running from near middle to distal end.

Claw of female genital forceps tripartite; basal spines 2÷2.

Length of male holotype, 9 mm.

Locality.—Alaska: Beluga Flats, 3—4 miles southwest of Beluga River on Cook Inlet. An adult male, the holotype, and several not fully developed females taken September 1–3, 1945. With the exception of the male, the specimens have lost their posterior legs.

Genus **Alaskobius,** new

Characterized in the male by having a dorsal lobe at end of fourth joint of anal legs, suggesting that present on the fifth joint in *Nadabius*. Antennae composed of twenty short articles. Ocelli seriate. Prosternal teeth 2÷2. Posterior angles of none of the dorsal plates produced. Anterior tarsi undivided.

Generotype: *Alaskaobius josephus*, n. sp.

Alaskobius josephus, n. sp.

A small form of a rufous yellow color. Antennae also rufous, but the legs paler and rufous.

Antennae very short. Ocelli on lower border of plate, in three oblique or two irregular longitudinal ones; e. g., 1÷3, 3, or 1÷2, 4.

Prosternal teeth pale, the median incision narrowly V-shaped.

Ventral spines of first legs 0, 0, 0, 0, 1, or 0, 0, 0, 1, 1; no dorsal spines. Second legs with or without a dorsal spine at distal end of fifth joint. Ventral spines of penult legs 0, 1, 3, 3, (2), 1; dorsal, 0, 0, 3, 1, 0; claw armed. Ventral spines of anal legs, 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; accessory claw present. None of coxae laterally armed.

Genital forceps with claw tripartite. Basal spines proportionately short, 2÷2.

Lobe of fourth joint of anal legs of male as shown in fig. 10.

Length, 7.5 mm.

Locality.—Alaska: Matnauska. A female holotype and female allotype taken May 7, 1945. A male paratype taken in October, 1943 Circle City. A male and female, June 21, 1945. Matanuska Valley Bodenburg Butte. One female, June 2, 1945, and numerous males and females taken August 23–31, 1943. Matanuska River at Hicks Creek. One female, September 17, 1945. Palmer. Four males and one female taken under stones, May 7, 1945, and a male and female taken October 16, 1943. Fairbanks. Many specimens taken September 21, 1943.

Alaskobius adlatus, n. sp.

Apparently a somewhat larger form than the preceding species. From the latter the male differs in having the dorsal lobe of the fourth joint of the anal legs smaller, with a wide longitudinal dorsal sulcus proximad of it. (see fig. 11). It also differs in having the ventral spines of these legs 0, 1, 3, 1, 0, instead of 0, 1, 3, 2, 0.

Length, about 9 mm.

Locality.—Alaska: Richardson Highway, 5 miles south of Rapids. One male.

Alaskobius parvior, n. sp.

Distinguished from the other two species in its much smaller size, fewer ocelli, etc.

Antennae very short. Ocelli 1÷2, the single ocellus small, the adjacent one largest.

Prosternal teeth 2÷2; the lateral margin of prosternum slanting directly back ectocaudad.

Ventral spines of anal legs 0, 1, 3, 2, 0; dorsal, 1, 0, 3, 0, 0; claws 2. Ventral spines of penult legs, 0, 1, 3, 3, 1; dorsal, 1, 0, 2, 1, 0. None of coxae laterally armed.

Claw of female genital claws tripartite. Basal spines 2÷2, short, broad at base but acuminate from base or near middle; those of each pair equal or nearly so.

Length, about 4.5 mm.

Locality.—College, near Fairbanks. One female taken September 22, 1943.

In the absence of the male, there may be some doubt as to this species belonging in *Alaskobius*, but the reference is probably correct. If the male should not confirm this disposition, the form would fall into *Oabius*, subgenus *Nyctobius*.

Family **Ethopolidae**

Ethopolys integer alaskanus Chamberlin

Ethopolys integer alaskanus Chamberlin, 1919, Canad. Arctic Exped., p. 21H.

This form has been previously recorded by the author from Sitka and Forrester Island where it was collected by H. and R. W. Heath in 1913.

Bothropolys (Oligopolys) ethus, new subgenus and species

This species is placed in a new subgenus on the basis of the lack of produced corners on any of the dorsal plates, the other known North American species having either the ninth, eleventh and thirteenth (Poropolys) or the sixth, seventh, ninth, eleventh and thirteenth dorsal plates (Bothropolys, sens. str.) with their posterior angles produced.

Antennae short, composed of the usual 20 articles. Eyes narrowly elongate, with ocelli in two or three series; e. g., 1÷5, 4, 3, the single ocellus contiguous and not enlarged.

Prosternal teeth 5÷5 or 4÷4, the special seta spiniform but much more slender than the teeth.

Coxal pores in the holotype in two series, those of the anterior series much smaller than those of the posterior or major series.

Ventral spines of first legs, 0, 0, 2, 3, 2; dorsal, 0, 0, 3, 2, 1; of the second, 0, 0, 2, 3, 2 and 0, 0, 3, 2, 2 respective; dorsal, 1, 0, 3, 1, 1. Ventral spines of the penult legs, 1, 1, 3, 3, 2; dorsal 1, 0, 3, 1, 1; accessory claw present minute. Ventral spines of anal legs, 1, 1, 3, 3, 2, 1; dorsal, 1, 0, 3, 2, 1 (claw missing on the only leg present but probably single). Last two pairs of coxae armed laterally as well as dorsally. Last coxae with a ventral spine as well as a lateral and dorsal one. Fourteenth coxae armed dorsally and laterally, the thirteenth armed dorsally only.

Length of type, 14 mm.

Locality.—U. S. Creek on Steese Highway, 62 miles northeast of Fairbanks. Two males taken June 20, 1945. One male, not fully mature (length 9 mm.), taken September 22, 1943.

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THE FULGOROIDEA, OR LANTERNFLIES, OF TRINIDAD AND ADJACENT PARTS OF SOUTH AMERICA, by R. G. FENNAH. Proceedings of the United States National Museum, Vol. 95, pages 411–520, plates 7–17, 1945.

According to the introductory statement "the fulgoroid fauna of the island is continental and has a close affinity to that of the Brazilian subregion, though being relatively impoverished." But if relatively impoverished, it seems still a rich fauna in view of the contents of the article, which is based chiefly on a collection made by the writer and that of the Imperial College of Tropical Agriculture. The article includes a large number of descriptions of new species and several of new genera. Keys are not provided.—A. W. L.

THE STANDARDS BY WHICH THE SPOTLESS PHASE OF HIPPODAMIA CONVERGENS IS JUDGED[1]

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It has been suggested by a specialist in the Coleoptera that the sizes of spots used in my ratings of the pattern of *Hippodamia convergens* (Coccinellidae) (Shull, 1944) should be put on record in order that others may more effectively distinguish the spotless phase in their collections. Students of this species will know, and others will easily understand, that the so-called "spotless" beetles often have spots. They could hardly have expected, until genetic work was done on the contrasted patterns, that spotless beetles (possessors of the dominant spotless gene) of certain lines of descent could as closely resemble the spotted ones as they were found to do.

In the experiments demonstrating this variability of the genetically spotless pattern it was necessary to use standard sizes of spots so that patterns could be expressed numerically. The scheme adopted was an arbitrary one, since the spots in a given position in different individuals form a finely graduated series. The largest size attained in each position was ascertained by examination of numerous spotted beetles in the strain used in the experiments. The diameters, or long axes, of these spots were then divided by four, and ideal spots created which had dimensions one-fourth, one-half, and three-fourths of the maximum dimensions. These spots are approximately shown in figure 1. Spots begin with a faint cloudiness; from that condition up to a dimension one-fourth of the maximum they were recorded as of size No. 1. From the one-fourth dimension to the one-half, the spots were rated as No. 2. From one-half to three-fourths was No. 3; from three-fourths to the maximum, No. 4.

In general, the size of the spots was estimated; to have measured them would have entailed prohibitive labor. Yet measurements were made at intervals to keep the standards fresh in mind. Allowance was made for differences in size of the beetles, and measurements of the elytra were made at intervals, particularly in large or small individuals, and in relation to measured spots of such individuals, to help maintain the standards. Some mistakes were of course made, as was demonstrated by rating the same beetles a second or third time after the earlier estimates were forgotten. But the errors were never more than 1, and the changes in subsequent estimates were about as often upward as downward. In a collection, therefore, the mean estimated size of the spots in a given position should be fairly accurate despite individual mistakes.

Occasionally a spot would be so lightly pigmented (sometimes a mere cloud) that it was placed in a class lower than that to which its

[1]Contribution from the Department of Zoology, University of Michigan. Aided by a gift from Mrs. S. Ralph Lazrus.

size entitled it. This was an attempt to make the amount of pigment the basis of classification, but no method was found of making the rank objective. Whether it was justifiable to make amount of pigment the basis, rather than the area covered, is not known.

Though all the spots fluctuate in size, the posterior three (arbitrarily numbered 4, 5 and 6) are the most useful in recognizing the spotless phase. Partly this is a consequence of their larger size. Partly it comes from their greater tendency to be absent; more spotless beetles lack their posterior spots completely than lack the three anterior ones completely. The scheme adopted for distinguishing the two patterns was therefore based on the three posterior spots only.

In some lines of descent there was no difficulty in recognizing the spotless individuals. In other lines, modifying genes reduced or nullified some of the inhibitory action of the spotless gene, and spots were enabled to develop. Where many of these modifiers existed in the same individual, the spots of a "spotless" beetle could be so large that the

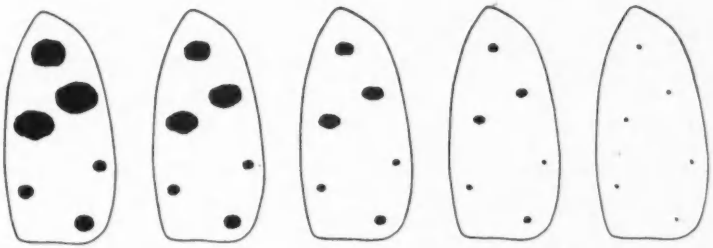

FIG. 1. Sizes of spots in *Hippodamia convergens*. Spots between 1 and 2 were rated 1, those between 2 and 3 were rated 2, etc. Minimal spots in first illustration could be mere cloudiness, not easily shown in ink drawings. Difficulties in engraving also prevent showing minimum size as small as it should be.

pattern would be regarded as spotted. This confusion existed only in certain pedigrees, and in these pedigrees the two patterns could be distinguished, in the overlapping group, only in a statistical sense. The combined rating of the three posterior spots of a spotted pattern could be at most $3\times4=12$. In the progeny of one pair of parents, it was determined that if the combined ratings of these three spots was more than 7.75 the beetle should be regarded as spotted, but if the combined ratings were less than that amount if should be considered spotless. This procedure should result in the proper proportion of the beetles having and lacking the spotless gene, but it would undoubtedly produce wrong judgments concerning some individuals.

Taxonomists should recognize the inadequacy of the system. The criterion proposed above was satisfactory for the group of beetles from which it was derived. In this group there were about four pairs of genes modifying the expression of spotless. These beetles were in Michigan. So far as has yet been determined, there are fewer than four pairs of modifiers in California. Presumably there are areas in

which more than four pairs exist. Whether the dividing value of 7.75 for the posterior spots would be valid in such areas cannot be known in advance of genetic work done on their populations.

Caution is also to be recommended against assuming that spots are suppressed only by the spotless gene. There are plain indications that in Colorado there are beetles of this species which would be called spotless according to the scheme proposed but which do not possess the gene for spotless. Too little genetic work has been done on the Colorado populations to indicate the system which prevails there.

A criterion of spotlessness, to be useful in the labeling of museum specimens, should be foolproof. It should be correctly applicable to individuals. A criterion which is valid only in a statistical sense is still useful in the highly important matter of geographic distinctions. The frequency of given alternative genes in a population is very significant in relation to evolutionary capacities. A population in which seven per cent of the pertinent chromosomes contain gene *S* is in a very different situation, with respect to future evolution, from one in which only two per cent of the chromosomes contain that gene. Geographic races depend on different distributions of certain genes. If smaller differences between gene frequencies can be demonstrated, the principles involved in geographic distribution can be applied to, and studied in, many new situations.

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ENTOMOLOGICAL NOMENCLATURE AND LITERATURE, by W. J. CHAMBERLIN. 135 pages, lithoprinted. Published by Edwards Brothers, Inc., Ann Arbor, Michigan, 1946.

The preface indicates that this volume was prepared for the use of students. For them it should be both helpful and stimulating, for it contains much practical information and some very interesting summaries of the lives and work of early scientists.

The author's advice to students on such problems as the nature of species and procedures in describing and naming them is clear and judicious. In such matters as the construction of keys he presents illustrations of the various patterns in use with a very clear analysis of their weaknesses and of the limitations under which they may be used. The summary of the International Rules and discussion of some of the problems of nomenclature also display excellent judgment and a laudably dispassionate treatment.

An abridged bibliography of this tremendous field could not fail to be subject to criticism if one cared to take up specific divisions. The writer has presented a selection of titles admirably comprehensive which should orient the student very satisfactorily and should prepare him to fill for himself the gaps that may be significant in his own work.

The volume concludes with directions for the preparation of manuscripts and other details of the process of publication. These directions are clear-cut and concise, and the remarks on the preparation of articles include some wise suggestions.

If Doctor Chamberlin's students follow his guidance they should make some valuable contributions to entomological learning.—A. W. L.

THE STRUCTURE OF THE GONADS OF THE WOOD-EATING BEETLE, PASSALUS CORNUTUS FABRICIUS

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This is the first part of a study on the development of the gonads of the wood-eating beetle, *Passalus cornutus* Fabricius, from their earliest appearance in the embryo to the definitive condition in the adult. Inasmuch as an intimate knowledge of the adult gonads is essential to an understanding of the development of these organs, the general morphology of the adult gonads will be discussed before their developmental history is traced.

STRUCTURE OF THE GONADS

In a consideration of the male genital system of the Coleoptera, Escherich (1894) concluded that the same fundamental plan predominates throughout the whole group. He used *Carabus* as an example of the most simplified type, and *Hydrophilus* as the more complex type, with *Blaps* as a somewhat intermediate form.

In *Carabus* the testis consisted of a simple, blind tube which twisted about and formed a coiled mass. The shape was ovoidal and somewhat tapering at the tip, and the whole convoluted region was enveloped by a fine tunic.

The testis of *Blaps* was nodule shaped and composed of two fascicles of short, radially arranged blind tubes. From each of the latter led a fine efferent duct, which united with the others to form a vas deferens. The peripheral end of each tube contained the sperm-forming cells, while the central part was filled with mature spermatozoa.

The third, still more complex type of testis, represented by that of *Hydrophilus*, was elongate and somewhat broad at the distal end, while narrowing at the proximal portion. It was composed of a very great number of fine, blind tubes about 1 mm. long, which were arranged radially with their long axes continuing proximally as efferent ducts.

Bordas (1900), with regard to the types of testes, divided the Coleoptera into two main groups; (1) those with simple, tubular testes, and (2) those with complex testes.

In the first group with simple, tubular testes belonged the Carabidae, Cicindelidae, Dytiscidae, etc., whose whole male genital system exhibited a primitive condition. The testes were composed of two cylindrical, more or less winding, coiled tubes. An enlarged region near the base served as a seminal vesicle. Histologically, the testes consisted of a very delicate external sheath and the genital cells.

The beetles with complex testes Bordas further divided into: (a) those with fascicular testes, and (b) those with cluster, or grape-like testes.

Those with testes composed of fascicles, that is, with the testicular follicles leading into the open end of the efferent duct, included the Aphodinae, Melolonthinae, Lucanidae, Chrysomelidae (except several genera), Curculionidae, Cerambycidae, etc. In all these the paired

testes consisted of 2–12 lobes of various sizes. These were spherical, ovoidal, or discoidal in shape, and each was divided into 50–100 truncate sections which led directly into a central reservoir by short efferent canals and then to the vas deferens.

To the group with testes composed of bunches of grapelike follicles belong the Tenebrionidae, Staphylinidae, Hydrophilidae, Silphidae, Coccinellidae, Elateridae, etc. The testes were made up of numerous club-shaped, cylindrical follicles which led directly into the central reservoir (Hydrophilidae, Staphylinidae), or into one of several lateral reservoirs.

In discussing the general morphology of the female reproductive organs, Snodgrass (1935) described a typical ovariole as consisting of three parts: a terminal filament, an egg tube, and a pedicel.

The slender, thread-like terminal filament at the distal part of the ovariole was a solid strand of cells enveloped by the tunica propria.

The egg tube was divided into the germarium, where the germ cells were in an active state of division and incipient differentiation, and the vitellarium, where the egg cells grew and attained their mature size. Beyond the last egg chamber a mass of follicle cells formed a "plug" which closed the proximal portion of the egg tube.

The pedicel, or stalk, was a short duct that connected the egg tube with the lateral oviduct.

Snodgrass stated that the ovariole is usually covered by "a thin structureless membrane known as the tunica propria." An "epithelial sheath" of flat cells is found outside the tunica in some insects. Imms (1938) and Comstock (1940) stated that muscle fibers were occasionally incorporated into this outer sheath.

Morison (1928) dealing with the various muscles of the honeybee, declared that all the muscles of the body showed striations. However, in a consideration of the muscles of the "reproductive organs" of the female, he inferred that muscles were lacking around the ovarioles for no mention was made of them at all.

In describing the various types of egg tube, Snodgrass used the generally accepted classification of Berlese, which divides them into panoistic, polytrophic, and acrotrophic types.

In the panoistic type there are no special nutritive cells differentiated from the egg cells. This type occurs in the Apterygota, Ephemerida, Odonata, Orthoptera, and Siphonaptera.

The Polytrophic type contains an alternating succession of oocytes and trophocytes, and is characteristic of the Anoplura, Neuroptera, Coleoptera-Adephaga, Lepidoptera, Hymenoptera, and Diptera.

A few insects, the Hemiptera and Coleoptera-Polyphaga, possess the acrotrophic type of egg tube. Here the oogonia give rise to nurse cells and oocytes. The former remain in the upper part of the egg tube, while the oocytes separate from them as the series of egg cells increases in the vitellarium. However, the original protoplasmic connections between the two sets of cells continue as long plasmatic strands. By means of these strands the oocytes in the egg tube continue to receive the yolk-forming material from the nurse cells. Consequently, the germarium in the acrotrophic type of ovariole could be looked upon as an apical feeding chamber for the oocytes.

OBSERVATIONS

The gonads of the adult male *Passalus* consist of two pairs of testes, one pair on each side of the body in the region of the third and fourth abdominal segments (fig. 1). Each of the four testes (*t*) is a slightly elongate cylindrical, bulb-shaped gland with a small nipple-like protuberance (*pt.*) at the extreme distal end. A narrow, eccentrically located duct leads from the testis to the seminal vesicle (*s. v.*) and vas deferens (*v. d.*). The duct from the other member of the pair also joins the same seminal vesicle. The efferent ducts from each side of the body unite in the midline and continue posteriorly as the single median ejaculatory duct (*ej. dt.*).

In the region of junction of the two vasa deferentia there are four elongate, blind tubular accessory glands (*ac. gl.*). The median pair are thick, winding, almost transparent glands, whereas the lateral ones are longer, more slender, more coiled, and quite opaque.

Around each individual testis is a peritoneal sheath (fig. 2). This investing coat is composed of a single sheet of cells and is bounded on each side by two very thin noncellular layers (*a* and *b*). The cell membranes of the epithelial sheath are not distinctly visible with the stains used. In many places small tracheae and tracheoles can be seen penetrating this outer peritoneal sheath.

Over the nipple-like protuberance the peritoneal sheath appears more complex (fig. 3). Here the continuations of the non-cellular layers (*a* and *b*) are much thicker, and the inner one (*b*) is divided into several sub-layers. From both of these layers many fine branches (*e*) can be seen extending into the cellular portion of the sheath and forming a reticular network of fine strands which are continuous with the non-cellular layers. Furthermore, the cellular part of the sheath is several cells thick, rather than a single layer as found in the proximal region of the testis (fig. 2). Although definite cell membranes are very difficult to make out even here, it is quite certain that the non-cellular strands (fig. 3, *e*) extend between adjacent cells. At the extreme tip of this region the inner layer (*b*) envelops a very small mass of cells (*d*) which are completely isolated from the remaining elements of the testis. The significance of this mass could not be determined.

Dividing the basal part of the testis into 20 to 25 or so wedge-shaped sections (figs. 4 and 5), the longitudinally arranged testicular septa extend from the proximal base of the testis nearly to the nipple-like part at the distal end. Each septum is composed of a thin cellular membrane with scattered elongate nuclei. At the peripheral region of the gland each testicular septum is joined to the adjacent one by a continuation of the membrane (figs. 2 and 4), (*c*) immediately beneath the enveloping peritoneal sheath.

Lengthwise through the center of the testis there extends a long, funnel-shaped sperm duct (figs. 4 and 6, *sp. dt.*). The funnel portion lies immediately proximal to the nipple-like protuberance at the distal end, and over the open entrance to the duct a dense irregular mass of cells arches in a somewhat dome-like fashion (fig. 6, *ep. ar.*). The sperm duct itself (fig. 8) is made up of tall columnar epithelial cells lying on a basement membrane with an irregular network underneath.

This duct leads out of the testis slightly eccentrically and enters the vas deferens via the seminal vesicle (fig. 1).

In the proximal portion of the young adult testis most of the cells are in some early phase of meiosis (fig. 9). This is indicated by the fact that the cut chromatin threads near the edge of the nucleus exhibit a paired or double condition, while there is little chromatin material toward the central region. These are probably in a meiotic phase just preceding the synapsis or pairing of the chromatin threads. Some other cells appear in slightly different phases of early meiosis.

In an older newly metamorphosed adult cysts of cells are undergoing the process of transformation into mature spermatozoa. These cysts are not restricted to any one definite region of the testis, but can be found both near the basal portion and farther distally.

Near the middle of the nipple-like protuberance many cells are being enveloped in cyst capsules. The chromatin material of these cells (fig. 10) is not limited to the peripheral region of the nucleus, as is the case in the preceding stage mentioned above. Here the chromatin tends to be densely packed near the center, although there is some distributed around the periphery and the chromatin threads do not exhibit a paired condition. Some other cells in the apical portion of the protuberance are slightly larger and are not yet enclosed in cyst capsules, but both types are evidently spermatogonia. Throughout the whole region of the protuberance mitotic figures are commonly visible.

In the sexually mature adult the basal part of the testis contains mostly the nearly complete spermatozoa. These are practically all located in the central region, lying near the sperm duct. Those near and in the funnel-like opening of the sperm duct under the epithelial arch seem to have been whirled around in such a way that these little balls of sperm are wrapped in their own tails. Toward the peripheral portion of the adult testis, surrounding the nearly mature spermatozoa, there are cysts of spermatids that have not yet undergone the process of transformation.

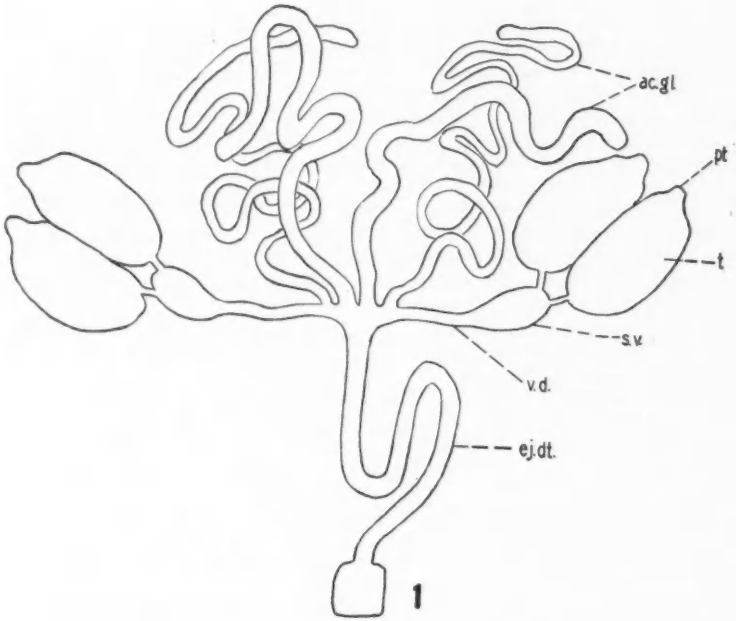
Like the male gonads, the female sex glands are also paired structures (fig. 12). The ovary on each side of the body is composed of two elongate, tapering, banana shaped ovarioles (*ov*) which join each other at their bases and connect with the lateral voiduct (*lt. ovd.*). The right and left lateral oviducts converge in the midline and continue posteriorly as the looped common oviduct (*cm. ovd.*). The latter duct connects with the vagina and bursa copulatrix (*b. cop.*). A prominent spermatheca and spermathecal gland lead into the bursa copulatrix.

EXPLANATION OF PLATE I

FIG. 1. Diagram of the male gonads and associated structures. *ac. gl.*—accessory gland; *ej. dt.*—ejaculatory duct; *pt.*—protuberance; *s. v.*—seminal vesicle; *t.*—testis; *v. d.*—vas deferens.

FIG. 2. Transverse section through the peritoneal sheath and part of a testicular septum of the testis. *a*—outer non-cellular layer; *b*—inner non-cellular layer; *c*—continuation of testicular septum; *p. s. n.*—nucleus of peritoneal sheath; *t. spt.*—testicular septum. ×825.

FIG. 3. Diagrammatic longitudinal section through the nipple-like protuberance of the testis. *a*—outer non-cellular layer; *b*—inner non-cellular layer; *d*—mass of enclosed cells at apex; *e*—branch of non-cellular network.



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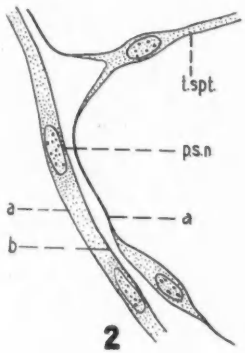

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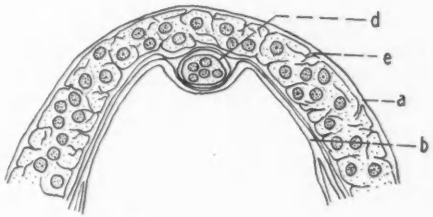

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Each ovariole is surrounded by a complex enveloping peritoneal sheath (fig. 11). Part of the sheath is made up of an inner circular layer (*c. mus.*) and an outer longitudinal (*l. mus.*) layer of muscles. These muscles are individual, spindle-shaped fibers that do not anastomose or branch, and they do not exhibit definite transverse or longitudinal striations, but appear to be like smooth muscles. The nuclei of these muscle fibers are usually located near the center, or slightly to one side of the center of the fiber. Outside the longitudinal layer, lying next to the hemocoel, there is a very thin cellular membrane (*a*), a typical mesothelium whose nuclei are very small and quite elongate.

As in the peritoneal sheath of the testis, many small tracheae and tracheoles can be seen penetrating the peritoneal sheath of the ovariole.

Immediately under this outer peritoneal sheath a thin, transparent, non-cellular sheath—the tunica propria (*t. p.*)—is found next to the cells of the ovariole.

At the extreme distal tip of the elongate ovariole is the terminal filament (fig. 13, *ter. fil.*) where the outer peritoneal sheath tapers to a fine thread-like structure.

Proximal to the terminal filament is the long germarium region (fig. 13, *germ*). Here the cells are packed tightly, have spherical nuclei, and appear to be all alike. The spiral-like tip of the germarium has relatively few nuclei and great amounts of brightly staining material (especially with Orange G and eosin). Even though a careful and detailed analysis of this material was not made, because of its apical position and characteristic staining, it seems quite likely that this region corresponds to the typical feeding chamber of the acrotrophic type of egg tube.

Between many of the cells of the ovariole in the central region there are large bright staining globules. However, no definite and continuous strands could be found connecting these with the spiral tip of the germarium.

In the region of the vitellarium (fig. 13, *vit*) several cells can be seen which have enlarged spherical nuclei and great amounts of cytoplasm (*ov*). There are transitional stages between those with smaller amounts of yolk material and as yet no follicle cells (fig. 14), and those with great amounts of yolk material and enclosed by a single, well-defined layer of follicle cells. Some of the medium sized cells show traces of plasmatic strands extending distally toward the germarium (figs. 13 and 16).

EXPLANATION OF PLATE II

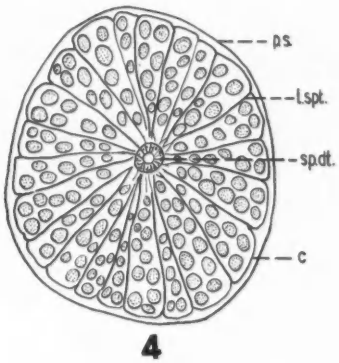
FIG. 4. Diagrammatic transverse section through the testis in the region of the sperm duct. *c*—continuation of testicular septum; *p. s.*—peritoneal sheath; *sp. dt.*—sperm duct; *t. spt.*—testicular septum.

FIG. 5. Diagrammatic longitudinal section of the testis to one side of the center. *sp. cy.*—sperm cyst; *t. spt.*—testicular septum.

FIG. 6. Diagrammatic longitudinal section through the center of the testis. b—mass of enclosed cells at apex; *ep. ar.*—epithelial arch; *pt*—nipple-like protuberance; *sp. cy.*—sperm cyst; *sp. dt.*—sperm duct.

FIG. 7. Diagram showing the path of sperm migration through the testis. *ep. ar.*—epithelial arch; *pt.*—protuberance; *sp. dt.*—sperm duct.

(See discussion for explanation of numbers.)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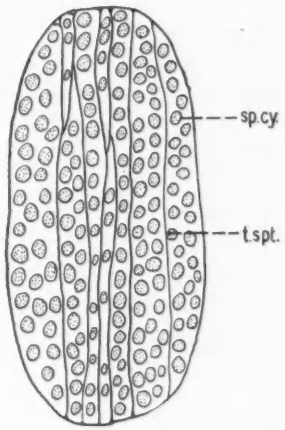
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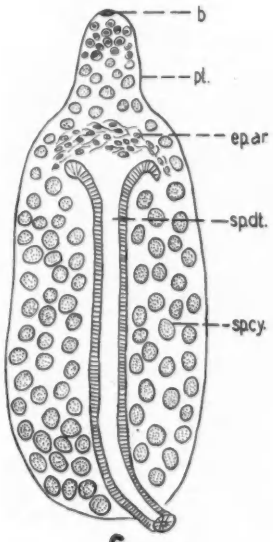
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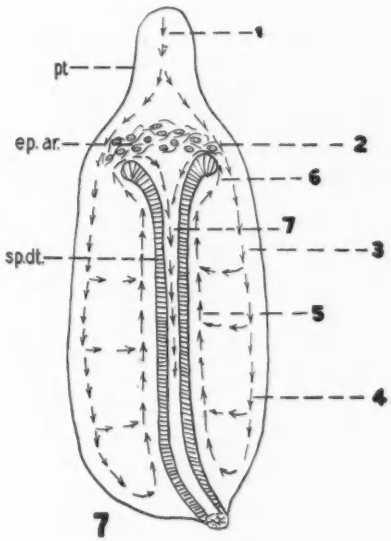
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In the upper vitellarium there are many cells with slightly enlarged pale nuclei (fig. 15, *b*). Some of these have the cytoplasm arranged in a somewhat star- or amoeba-shaped form. It seems plausible that these blunt projections are the precursors of the relatively longer plasmatic strands of the enlarging oocytes (fig. 16).

Beyond the last and largest egg in the vitellarium is the epithelial plug (fig. 13, *ep. pl.*). An enlarged view of this area (fig. 17) reveals that it is a dense, somewhat irregular mass of follicle cells. In some regions of the plug, the follicle cells are very thin and elongate. This is at least partially due to the lateral stretching of the ovariole as a result of the tremendous increase in size of the developing ova. At the basal portion is the pedicel (fig. 13, *pd*), or stalk, by which the ovariole is attached to the lateral oviduct.

DISCUSSION

STRUCTURE OF THE MALE GONADS

Although the paired condition of the male gonads in *Passalus* is quite typical of many coleopteran testes, there are several other features which are rather unique.

According to the classifications of Bordas (1900) and Escherich (1894) the coleopteran testis is either a simple blind tube or a number of blind club-shaped follicles leading into the vas deferens via the vasa efferentia.

But in *Passalus* the testis is not a blind tube, nor is it divided into club-shaped follicles. Instead, there are 20–30 longitudinal testicular septa extending almost the whole length of the testis from distal to proximal regions, and radiating, like spokes of a wheel, from the centrally located sperm duct (figs. 4 and 6).

Similarly, the central sperm duct is somewhat atypical. This long, funnel-shaped canal extends from just below the nipple-like protuberance to the base of the testis and into the seminal vesicle. There are no efferent ducts entering the sperm duct along its course, and the only entrance to the canal is at the anterior, distal portion where the funnel-like mouth flares out (fig. 6).

Over this flared out opening to the sperm duct the mass of epithelial cells arches like a dome or roof. The significance of this epithelial arch will be discussed presently.

EXPLANATION OF PLATE III

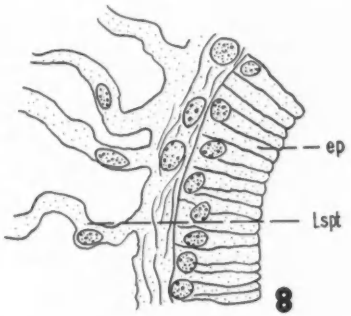
FIG. 8. Transverse section through the sperm duct of the testis. *ep.*—epithelial cell; *t. spt.*—testicular septum. × 825.

FIG. 9. Group of cells from sperm cyst in basal portion of newly metamorphosed adult. × 825.

FIG. 10. Cell from cyst near middle portion of protuberance in newly metamorphosed adult. × 825.

FIG. 11. Longitudinal section through the peritoneal sheath and tunica propria of the ovariole. *a*—epithelial membrane; *l. mus.*—longitudinal muscle layer; *c. mus.*—circular muscle layer; *p. s.*—peritoneal sheath; *t. p.*—tunica propria. × 825.

FIG. 12. Diagram of female gonads and associated structures. *b. cop.*—bursa copulatrix; *cm. ovd.*—common oviduct; *ov*—ovariole; *spth*—spermatheca; *spth. gl.*—spermathecal gland.



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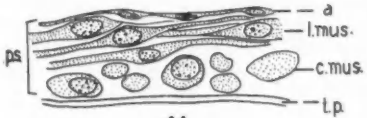

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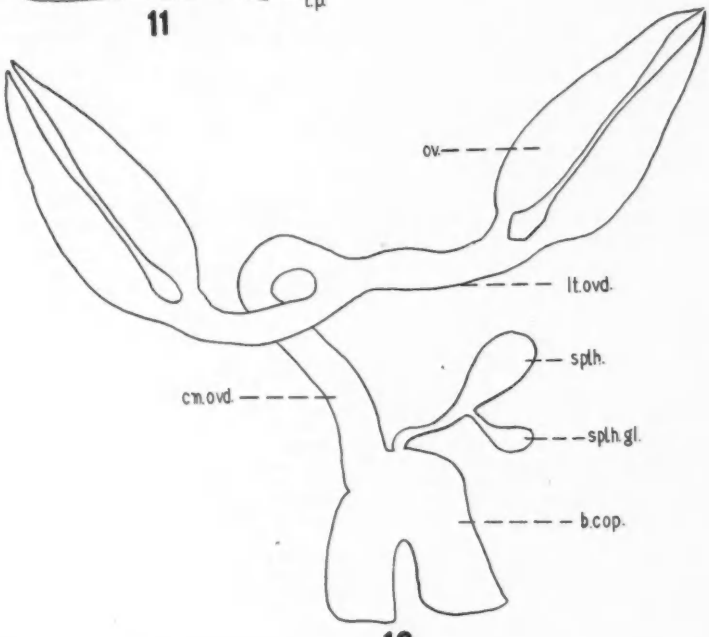

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The little nipple-like protuberance at the extreme distal tip of the testis is also an interesting and unusual structure. It is here that the first stages of spermatogenesis evidently occur (fig. 7–1). As the development of the male sex cells ensues, they migrate away from this region toward the basal portion of the testis. They are prevented from entering the open funnel-like sperm duct by the epithelial arch which guides them around the opening (2) into the proximal portion of the testis between the testicular septa (3). The significance of the mass of cells enclosed by the non-cellular layers (fig. 3, *d*) could not be determined.

In a newly metamorphosed adult the lower part of the testis (fig. 7—3 and 4) is filled with male sex cells undergoing the early phases of meiosis. Presently, some cysts of cells can be seen in the early periods of spermiogenesis, or transformation. These transforming cells seem to exhibit no regular or definite arrangement either transversely or longitudinally. That is, metamorphosing cells can be found near both the peripheral and the central regions of the gland, as well as in both the distal and proximal regions. As the breeding season approaches and the transformation into spermatozoa has been nearly completed, the almost mature spermatozoa tend to gather in the central region (5). Then they migrate distally along the sperm duct, pass under the epithelial arch (6), around the rim of the funnel, and into the efferent sperm duct (7). As the bunches of spermatozoa pass up around the sperm duct under the epithelial arch and around the rim into the funnel, they seem to be subjected to some sort of whirling movement which tends to wrap the long tails around into little balls. However, as they pass out of the sperm duct this ball-like condition disappears and the individual spermatozoa pass into the seminal vesicle.

Although a detailed and extensive study of the stages of spermatogenesis in *Passalus* was not made or intended, it is quite obvious that the conditions of this process are somewhat different from those typcially found in insects. In the blind-sac, or club-like follicles of most coleopteran testes the process of spermatogenesis originates at the distal apical region and continues in a wave-like fashion toward the proximal portion. At any particular region of the follicle all of the developing cells are in approximately the same phase. Thus, very definite regions

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EXPLANATION OF PLATE IV

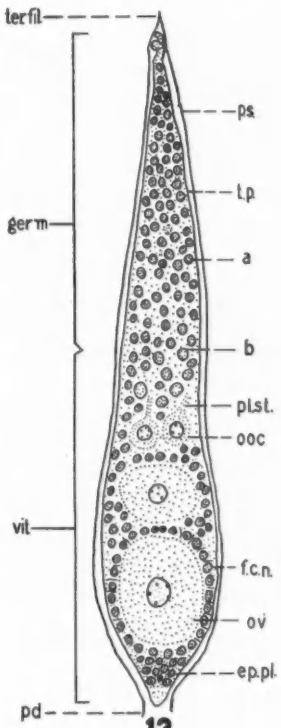
FIG. 13. Diagrammatic longitudinal section through the ovariole. *a*—nucleus of undifferentiated egg cell; *b*—nucleus of enlarging egg cell; *ep. pl.*—epithelial plug; *f. c. n.*—follicle cell nucleus; *germ.*—germarium; *ooc*—enlarging oocyte; *ov*—large egg cell with follicle cell envelope; *pd*—pedicel; *pl. st.*—plasmatic strand; *p. s.*—peritoneal sheath; *ter. fil.*—terminal filament; *t. p.*—tunica propria; *vit*—vitellarium.

FIG. 14. Small ovum just beginning to enlarge. × 825.

FIG. 15. Group of cells from anterior region of vitellarium. *a*—undifferentiated cell; *b*—cell with enlarged nucleus and pseudopodia-like cytoplasmic processes. × 825.

FIG. 16. Enlarging oocyte showing traces of plasmatic strand. × 345.

FIG. 17. Group of follicle cells forming the epithelial plug beyond the last and largest ovum in the egg tube. *f. c.*—follicle cell of epithelial plug; *ov*—last ovum in egg tube. × 345.



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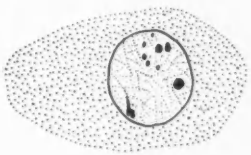

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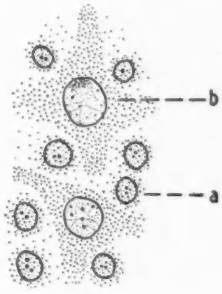

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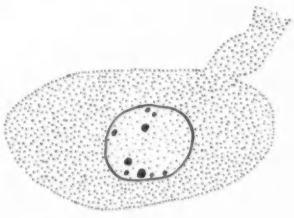

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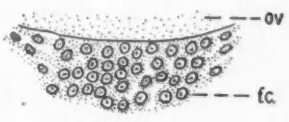

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can be identified, such as: "zone of growth," "zone of division and reduction," "zone of transformation," etc. When a spermatogonium increases in size, the process takes place in the "zone of growth." When the spermatocytes undergo their meiotic activities and became spermatids they are located in the "zone of division and reduction." And when spermatids begin to metamorphose into spermatozoa this activity takes place at the "zone of transformation."

In *Passalus* there does not seem to be any definite region where the cells are always in one particular phase. It is true, however, that the spermatogonia are located at the extreme apex, and this region could properly be called the germarium. But in the region near the sperm duct, for example, the cells may be in early meiotic activity, or they may be nearly complete spermatozoa, depending upon the age of the beetle.

The enveloping peritoneal sheath corresponds to that usually found surrounding the typical testes of beetles, but the fact that it is composed of a sheath of cells enclosed by two thin non-cellular layers is rather unusual. This is especially true in the region of the protuberance, where it becomes even more complex.

STRUCTURE OF THE FEMALE GONADS

While the female gonads of *Passalus* conform more closely to the typical coleopteran pattern than do the testes, the ovaries do exhibit several peculiarities in structure.

The fact that the paired ovaries are each composed of two slender, elongate, banana-shaped ovarioles is not unusual, nor is the fact that each is enclosed by two investing sheaths—the outer peritoneal sheath and the inner non-cellular tunica propria.

But the structure of the outer sheath is interesting because it is made up of several component parts (fig. 11). In the internal portion this sheath is composed of a circular layer of muscle fibers, and just external to this layer, a layer of longitudinal muscles. Imms (1938) states that a muscle "reticulum" is often found in the peritoneal sheath, which implies a network of branching or anastomosing fibers. In *Passalus* both muscle layers are apparently composed of single, individual muscle fibers. However, while they are not absolutely uniformly or regularly arranged, there is nothing to indicate a "reticulum" composed of branching or anastomosing fibers. Rather, the fibers seem slightly twisted about each other in a somewhat felt-like arrangement.

The muscles of insects are invariably described as all being of the striated type. However, not many authors have dealt with the muscles of the gonads proper, but only with the muscular tissue in the efferent ducts or copulatory organs of the reproductive system.

Neither the longitudinal nor the circular muscles of the peritoneal sheath in *Passalus* exhibit definite transverse or longitudinal striations. Instead, the individual fibers resemble the spindle-shaped smooth muscles characteristic of the "involuntary" muscles of vertebrates. In the region of the oviduct the striations can be recognized without much difficulty. As there is a much greater amount of muscular tissue present here, it may well be that the mere quantity of fibers emphasizes the

striated condition. On the other hand, there seems to be no obvious reason why a type of smooth muscle should not be found in some structures in insects. Perhaps, then, the ovariole sheath in *Passalus* does possess a relatively rare type of non-striated muscle fiber.

An outer thin membrane lying next to the hemocoel surrounds the longitudinal muscle layer and resembles a typical mesothelium (fig. 11, *a*). This thin layer undoubtedly corresponds to the "peritoneal membrane" often described in other insects.

While the tunica propria is typically described as a "thin structureless membrane," it is perhaps more consistent to refer to it in *Passalus* as a non-cellular transparent sheath. And likewise while some authors call the peritoneal sheath an "epithelial" membrane, and others, a connective tissue coat, in *Passalus* it is obviously a complex sheath of two layers of muscles covered externally by an epithelial membrane. However, the term "peritoneal sheath," is entirely appropriate and adequate for this investing coat.

According to Deegener (1914), Imms (1938), Snodgrass (1935) and others, the typical ovariole of the Coleoptera-Polyphaga belongs to the acrotrophic, or telotrophic type, where the nurse cells are found at the tip of the ovariole. Although the spiral-like tip of the germarium in *Passalus* was not carefully studied cytologically, it seems quite likely that it does perform some sort of nutritive function as would be expected in this beetle. The fact that much bright staining material is present at the tip of the ovariole, and the fact that at least the smaller developing egg cells possess plasmatic strands definitely indicate that the ovariole in *Passalus* is the typical acrotrophic type. However, direct protoplasmic connections could not be demonstrated between the oocytes and the distal spiral tip. Inasmuch as large globules of a similar bright-staining material were frequently seen in the germarium proper, it is quite evident that some sort of protoplasmic connection does exist.

No plasmatic strands were seen on the egg cells which were enveloped by follicle cells, and it is probably true that the smaller oocytes receive nourishment from the apical feeding chamber via the plasmatic strands until they acquire a follicle cell envelope of their own.

Because the significance of the terminal filament can be more easily interpreted in light of its development, the consideration of this structure will be postponed for the present.

The remainder of the ovariole is also quite typical in construction (fig. 13). The vitellarium contains the developing egg cells and surrounding follicle cells. Beyond the last and largest ovum is the epithelial plug of follicle cells, which prevents unripe ova from escaping into the oviduct.

SUMMARY

1. The structure of the gonads in the male *Passalus cornutus* is rather atypical, and in many respects differs from the characteristic conditions usually found in beetles. In the young adult the gonads consist of two pairs of bulb-shaped testes, one pair on either side of the body. Each of the four testes is surrounded by a peritoneal sheath composed of a sheet of cells bounded by two thin non-cellular layers.

A central funnel-shaped sperm duct courses almost the whole length of the testis and leads into the seminal vesicle and vas deferens. The gland is divided into 20 to 30 long, wedge-shaped sections by epithelial testicular septa which radiate around the central sperm duct, and extend almost the whole length of the testis.

2. At the distal tip of each testis there is a peculiar little nipple-like protuberance the apex of which can be considered as the germarium, since here the early stages of spermatogenesis take place. Just adjacent to the little hillock is an epithelial arch of dense cells that extends dome fashion over the funnel-like mouth of the sperm duct. This arch guides the migrating sperm cysts from the protuberance into the testis proper, and prevents the escape of immature sex cells. The sperm cysts continue their maturation within the confines of the testicular septa. When the spermatozoa are to be discharged, they migrate distally toward the tip of the testis, pass under the epithelial arch and into the flared-out opening of the sperm duct.

3. The ovary on each side of the body is composed of two elongate, banana shaped ovarioles that join each other at their bases and are continuous posteriorly with the lateral oviduct. Each ovariole is enveloped by two coats. The outer peritoneal sheath is made up of an inner circular layer and an outer longitudinal layer of non-striated muscles. These in turn are covered by a thin epithelial membrane lying next to the hemocoel. A transparent non-cellular tunica propria is located between the peritoneal sheath and the cells of the ovariole.

4. The ovariole corresponds to the typical acrotrophic type usually found in the Coleoptera-Polyphaga, and consists of the following regions: (a) a distal terminal filament, (b) a germarium, where at the spiral distal tip there is a bright-staining nutritive chamber, and at the basal portion the cells are in an undifferentiated condition; (c) a vitellarium, where the oocytes become enveloped by follicle cells and develop into mature ova, and which contains an epithelial plug that prevents the immature egg cells from escaping; and (d) a pedicel, or stalk, which attaches the ovariole to the lateral oviduct.

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THE GENUS SANCTANUS IN NORTH AMERICA INCLUDING THE MEXICAN SPECIES

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The Genus *Sanctanus* was erected by Ball[2] in 1932 to include a small group of species formerly placed in *Scaphoideus*. He cited *Scaphoideus sanctus* Say as the genotype. In addition he placed *fasciatus* Osb., *cruciatus* Osb., *orbiculatus* Ball, *aestaurium* DeL. & S., *limnicolus* Osb., *eburneus* DeL. and *fusconotatus* Osb. in the Genus *Sanctanus*. Later Oman,[3] 1934, made a key to the species of the genus in which he included *tectus* which he described at that time. In 1938 Beamer[4] described *balli* as closely related to *sanctus*. This previous work included largely North American species. Recently the writers have been studying a large amount of material belonging to this genus, which was collected in Mexico. As a result it has been found that five new species, *similarus*, *pallidens*, *galbus*, *apicalis* and *elongatus* are closely related to *sanctus* and *balli*. One other, *elegans*, is more closely related to *orbiculatus*. In the *fasciatus* group there are apparently five species occurring in Mexico, four of which, *virgatus*, *marginellus*, *sonorus* and *dampfi*, are apparently new and closely related to *fasciatus* and *cruciatus*. In color pattern many of these species could scarcely be distinguished from closely related forms unless the male genital characters are used. In the *sanctus* group the aedeagus is quite similar in type in several of the species but the character of the style will distinguish them very easily. In the *fasciatus* group the aedeagus and styles are similar in type but the characters of the plates will separate these into species and the color patterns are of assistance in a few cases. The male genitalia of *fusconotatus* and *aestuarium* are very similar and unique. The color pattern of the head will distinguish these species and the vertex in *fusconotatus* is apparently more produced than in *aestuarium*.

During this study most of the types have been examined and the genital structures studied. The types of *cruciatus*, *fasciatus*, *neglectus*, *fusconotatus*, *limicolus* and *picturatus* in the Osborn collection and the types of *aestuarium* and *eburneus* in the senior author's collection have been available at the Ohio State University. The type of *orbiculatus* Ball and *tectus* Oman have been examined at the National Museum. The authors desire to express their appreciation for the courtesies extended by Prof. J. N. Knull and Dr. J. S. Caldwell for the examination of types in the collections of these two institutions.

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[2]Jour. Wash Acad. of Sci. 22: 10. 1932.

[3]Proc. Ent. Soc. of Wash. 36: 75–76. 1934.

[4]Can. Ent. 70: 244. 1938.

Genus **Sanctanus**

The genus is characterized by having a somewhat flat vertex which is acutely angled with the front. The elytra have a second cross nervure between the sectors and the second anteapical cell is constricted and divided. The first anteapical cell is usually quite short, narrowed at both ends with one or more reflexed veinlets to the costa. Most of the species of the genus have a dark saddle-like marking or a dark cruciate spot on the elytra which usually obscures the venation.

The genus seems to contain two allied groups of species which differ somewhat in structure and appearance. Two subgenus names are therefore proposed. The forms with a produced pointed head are placed in the subgenus *Sanctanus* with *sanctus* Say as the type. The broad blunt-headed species are placed in the subgenus *Cruciatanus* with *cruciatus* Osborn as the type.

The subgenus *Crucialanus* is characterized by a broad blunt head and with a zigzag broad dark band which does not reach the costal margin. The male styles in this group are not notched on the outer margin before the apex but are curved and abruptly narrowed at about the middle to form long slender processes on the apical half. The aedeagus has a shallow excavation on the dorsal surface near the middle on the basal half. The six species, *cruciatus*, *fasciatus*, *marginellus*, *dampfi*, *sonorus* and *virgatus* belong to this subgenus.

KEY TO SPECIES

1. Elytra white with a median brown cruciate mark across posterior two-thirds of clavus extending to costa and forming a broad white marginal band along scutellum across base of elytra and another white oblique band from apex of clavus to costa across base of anteapical cells—(*sanctus* group) 2
1'. Elytra without a brown median "saddle" reaching to costa and forming a white marginal band along scutellum and across anteapical cells 8
2. (1). Vertex and above definitely tinted with yellow, face and beneath bright orange yellow; male aedeagus decidedly broadened or inflated at middle ..... **gelbus**
2'. Vertex milky white or pale yellow, face and beneath pale, not orange. Male aedeagus not strongly inflated at middle 3
3. (2'). A marginal row of spots just above margin of vertex larger and appearing more connected in a broken line ..... **pallidens**
3'. Spots above margin of vertex minute and rounded if present, not appearing elongated or connected 4
4. (3'). Apical portion of male styles beyond constricted portion as long or longer than basal half. Aedeagus in ventral view with a pair of separated broadened processes produced beyond apex ..... **sanctus**
4'. Apical portion of styles beyond constriction less than half the length of basal portion. Aedeagus in ventral view with apical processes pointed 5
5. (4'). Apical portions of styles slender, elongate, fingerlike 6
5'. Apical portions of styles broadened beyond constriction to width of style before constriction 7
6. (5). Style abruptly notched on outer margin to form fingerlike apex. Aedeagus enlarged just before apex, broadened on ventral side .... **balli**
6'. Style only faintly notched to form fingerlike apex. Aedeagus with a dorsally produced process just before apex ..... **similarus**
7. (5'). Style indented at middle on broad apex forming a pair of "cat ear" processes. Aedeagus slightly broadened at middle and tapered to a pair of sharp pointed processes ..... **elongatus**

7'. Style with apical margin straight, sloping to outer margin. Apical portions of aedeagus slender not broadened at middle.....**apicalis**
8. (1'). Elytra white with a small brown spot on middle of clavus and a brown band across inner anteapical, apical portion of central anteapical and the first apical cells. Corium white, unmarked.....**eburneus**
8'. Elytra with dark markings on costa or corium in the form of spots or stripes.....9
9. (8'). Elytra salmon colored with dark markings.....10
9'. Elytra not salmon colored; with dark bars or stripes.....11
10. (9). Vertex with two apical black spots, pronotum unmarked, corium of elytra without longitudinal white stripes.....**orbiculatus**
10'. Vertex unmarked, pronotum with two large black spots on humeral angles, corium of elytra with a broad white longitudinal stripe..**elegans**
11. (9'). Vertex white with two transverse brown bands between the eyes. Elytra dark brown with white veins, appearing longitudinally striped.....**virgatus**
11'. Elytra with dark spots or zigzag bands, not appearing longitudinally striped.....12
12. (11'). Elytra with numerous supernumerary veinlets on the anteapical cells.....**limicolus**
12'. Without supernumerary veinlets on anteapical cells of elytra.....13
13. (12'). Dorsal color pattern consisting of brown or yellowish brown and ivory. Brownish area on disc of corium not broken by broad white or pale veins—(*fasciatus* group).....14
13'. Dorsal color pattern lacking in distinct brown and ivory contrasts. Markings on corium consisting mostly of brownish intra-cellular infuscations which are darker around the margins. Veins on disc of corium broad and pale.....18
14. (13). Entire upper surface embrowned with a row of elongated brown spots forming a broken marginal line just above margin of vertex..**marginellus**
14'. Dorsal surface with contrasted areas of milky white and brown.....15
15. (14'). Pronotum white with a broad broken brown band across middle. Scutellum white with three dark brown spots, one at apex and one in each basal angle. Male plates tapered to form blunt rounded apices.....**cruciatus**
15'. Pronotum and scutellum brownish with faint markings. Male plates broadly rounded, not narrowed to blunt rounded apices.....16
16. (15'). Male plates decidedly longer than styles.....17
16'. Male plates about the same length as styles.....**fasciatus**
17. (16). Vertex distinctly produced and bluntly angled; male plates broadly convexly rounded to straight inner margins.....**sonorus**
17'. Vertex short, blunt, broadly rounded; male plates narrow, convexly rounded from both inner and outer margins to form a broadly rounded apical margin which is almost as broad as basal width of plate..**dampfi**
18. (13'). Upper half of face uniformly black. Vertex without heavy dark markings on disc.....19
18'. Black marks on upper portion of face consisting of broken transverse band with white transverse bars. A pair of large round black spots between anterior portion of eyes on disc.....**tectus**
19. (18). With dark fuscous marks above margin on anterior portion of vertex next each eye.....**fusconotatus**
19'. Vertex with pale orange markings on disc; no dark markings above margin.....**aestuarium**

Sanctanus sanctus (Say)

Jassus sanctus Say. Jl. Acad. Nat. Sci. Phila. VI, p. 307, 1831, Compl. writ. II, p. 383.

A white species with a brown cruciate mark across middle of elytra. Length 5 mm.

Vertex rather sharply angled, almost as long at middle as basal width between eyes.

Color: White, often gray in appearance and tinted with yellow or tawny. Vertex with a pair of minute spots at apex. Elytra white with a brown cruciate mark at middle and another dark band across the cross veins and apex.

Genitalia: Female last ventral segment almost truncate with a slight median notch. Male plates gradually narrowed on outer margins to form sharp-pointed apices. Style elongate, notched on outer margin before middle, the apical half narrow, finger-like and blunt at apex. The aedeagus in ventral view is broadened at apex with a rounded excavation at middle, forming a pair of blunt, truncate apical processes.

This is the common species of this genus throughout the eastern United States.

Sanctanus balli Beamer

Sanctanus balli Beamer. Can. Ent. 70: 224, 1938.

In general appearance and coloration resembling ***sanctus***, but with distinct genitalia. Length 5–5.75 mm.

Vertex produced and angled, but wider between eyes at base than median length.

Color: Milky white, tinted with yellow, vertex with a pair of minute darker spots near apex and the two larger irregular angled dashes near base. Pronotum and scutellum pale with dark mottling. Elytra white with the typical brown cruciate mark near middle and a narrow fuscous stripe on cross veins which is Y-shaped. Cruciate mark at middle, darker margined.

Genitalia: Female last ventral segment with lateral angles slightly curved to a posterior margin which is slightly sinuate, bearing a slight, narrow V-shaped notch at middle. Male plates with outer margins roundly produced to sharp apices. Male style rather short, a deep notch on outer margin about one-third the distance from apex, the apical finger process blunt at apex. Aedeagus in ventral view enlarged just before apex, then tapered to a pointed spear-like tip.

This species has been reported only from Arizona.

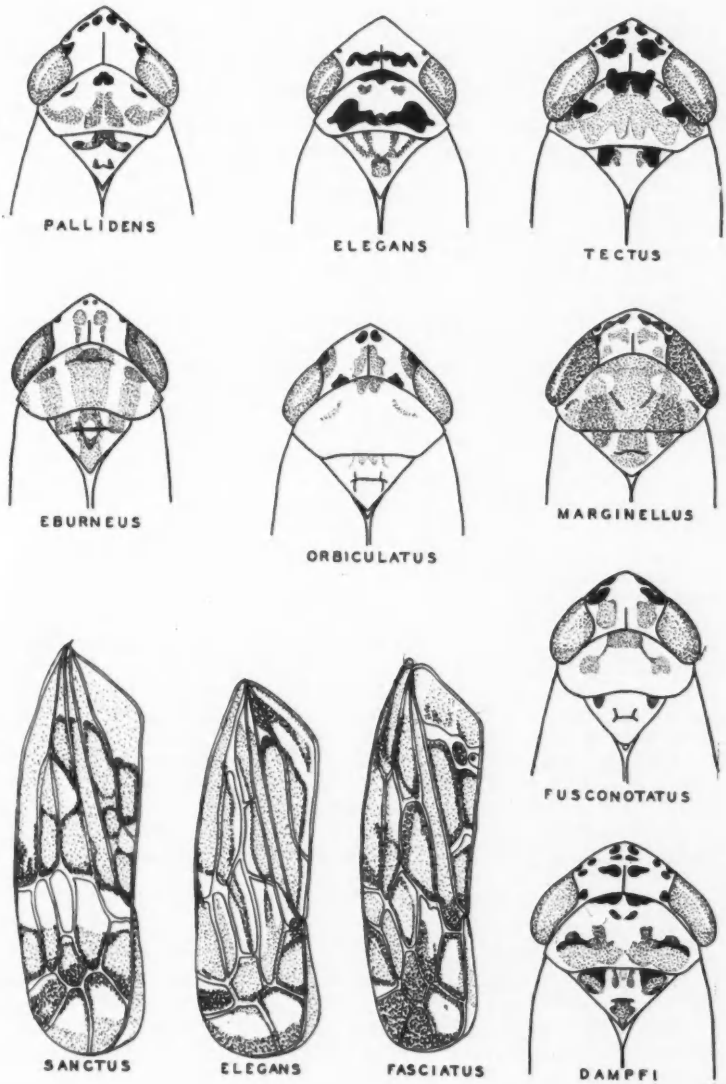
Sanctanus similarus n. sp.

Resembling ***sanctus*** in form and general appearance but paler and with different male genitalia. Length 4–4.5 mm.

Vertex bluntly angled, about as long at middle as basal width between eyes.

Color: Face pale with traces of a few arcs on upper portion. Ocelli black. Vertex dirty white, unmarked. Pronotum and scutellum white, tinged with green. Elytra white with a pale brown cross extending from costal margin across clavus, forming a small round white spot on clavus next suture. A brownish spot bordering the cross veins between apical and anteapical cells.

Genitalia: Female last ventral segment roundedly produced from base with a portion of the underlying segment visible at each side. Male style with apical third distinctly narrowed and bent outwardly. The apex tapered to a bluntly pointed tip. Plates about the length of pygofer, elongate, triangular, acutely pointed. The aedeagus is a single



Dorsal views of head, pronotum and scutellum of species of *Sanctanus* as labeled. Lower left—view of left elytron of three species as labeled.

tubular process with apex bent downwardly, a pair of lateral processes at apex are turned upward.

Holotype male collected at Huetamo, Gro., August 22, 1933, (M. F. 3100), by Dr. Dampf. ***Allotype*** female taken at Tuxtla, Gutierrez, July 29, 1936 (M. F. 1055), by Dr. Dampf. Male and female ***paratypes*** from Huetamo and Iguala, Gro., Sept. 11, 1939, and Oct. 25, 1941, collected by Good, Plummer and DeLong.

Sanctanus pallidens n. sp.

Resembling *sanctus* in general form, but with different color markings and male genitalia. Length 4–4.5 mm.

Vertex appearing sharply angled in female, blunter in male, a little wider between eyes at base than median length.

Color: Face washed with pale brown, traces of arcs on upper portion, usually a brown transverse band between antenna. Vertex yellowish in male with a pair of brown apical spots and a fainter spot next each eye. Eyes and ocelli red. Vertex in female sordid yellow, with the four spots somewhat coalescing to form a broken marginal line. Other irregular dull spots are on disc and base. Pronotum and scutellum dirty white, tinged with green. Elytra pale dirty white, tinged with green. The cross mark from costal margin extending across clavus is pale brown, often scarcely visible in males. There is a brown spot bordering the cross veins of the anteapical cells.

Genitalia: Female last ventral segment roundedly produced from base to form a slightly concave posterior margin which is embrowned at middle. The lateral portions of the underlying segment are exposed on either side. Male plates decidedly shorter than pygofer, triangular, with blunt apices. Style rather deeply narrowly notched just before apical fifth which is a fingerlike process. Aedeagus elongate in lateral view, slightly broadened at middle, tapered to a narrow apex which is slightly upturned. In ventral view it is bifid on apical half with the two straight portions proximal.

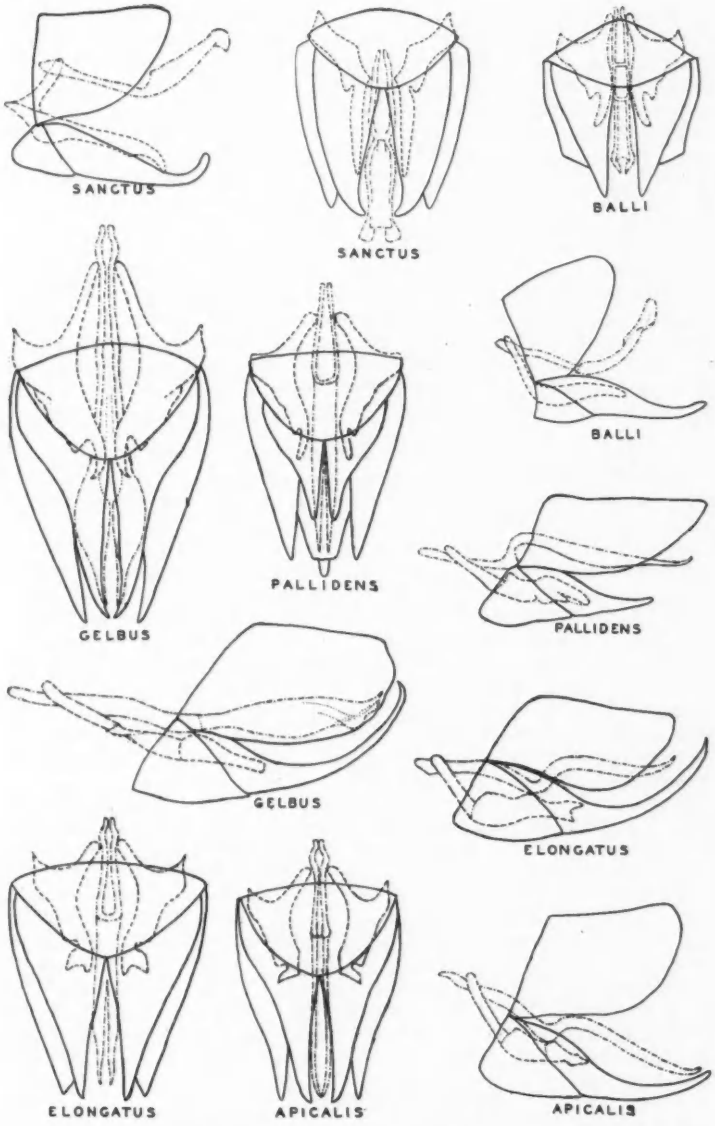
Holotype male, ***allotype*** female and male and female ***paratypes*** collected at Iguala, Gro., Sept. 11, 1939, by Plummer and DeLong and October 25, 1941, by Good and DeLong. Male and female ***paratypes*** collected at Huetamo, Gro., August 22, 1933 (M. F. 3100), and Yaqui Valley, Sonora, August 16, 1927 (M. F. 1295A), by Dr. Dampf.

Sanctanus gelbus n. sp.

Resembling pale specimens of *sanctus* in general appearance, but with distinct male genitalia. Length 4–4.75 mm.

Vertex strongly angularly produced, a little wider between eyes at base than median length.

Color: White, with pale brown markings on elytra. Vertex, pronotum and scutellum white, washed with yellow or orange. Face and beneath yellow to orange, the males are usually more darkly marked. Elytra milky white with a rather pale brownish cross extending from costal margin across clavus with a small enclosed white spot on clavus. A pale brownish spot across apices of elytra, veins white, rather heavily bordered with dark brown.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Genitalia: Female last ventral segment more than three times the length of preceding segment. Strongly roundedly produced from base to form a broadly rounded posterior margin which is slightly broadly notched at middle. Male plates as long as pygofers, convexly rounded at apex, slightly concave on inner margins and acutely pointed. Style deeply, broadly notched on outer margin one-fifth the distance from apex, the apical process narrowed, curved outwardly at tip and acutely pointed. Aedeagus distinctly inflated at middle both in lateral and ventral views, rapidly narrowed to a sharp pointed apex.

Holotype male, *allotype* female and male and female *paratypes* collected at Puenta de Ixtla, Mor., Mexico, October 21, 1941, by Good and DeLong. Male and female *paratypes* collected at Iguala, Guerrero, Mexico, September 11, 1939 by Plummer and DeLong; and at Taxco, Gro., K-155, October 6, 1945, elevation 5,500 feet, by Balock, Elliott, Hershberger and DeLong; Tierra Colorado, Gro., K-271, October 5, 1945, elevation 1,500 feet, collected by Balock, Elliott, Hershberger and DeLong; Cuernavaca, Mor., K-6-east, Sept. 25, 1945, elevation 4,800 feet, by Plummer, Shaw, Elliott, Hershberger and DeLong.

Sanctanus apicalis n. sp.

Resembling *sanctus* in general form and appearance but with spots on the vertex and different male genitalia. Length 4–4.5 mm.

Vertex strongly produced, bluntly angled at apex, a little broader between eyes at base than median length.

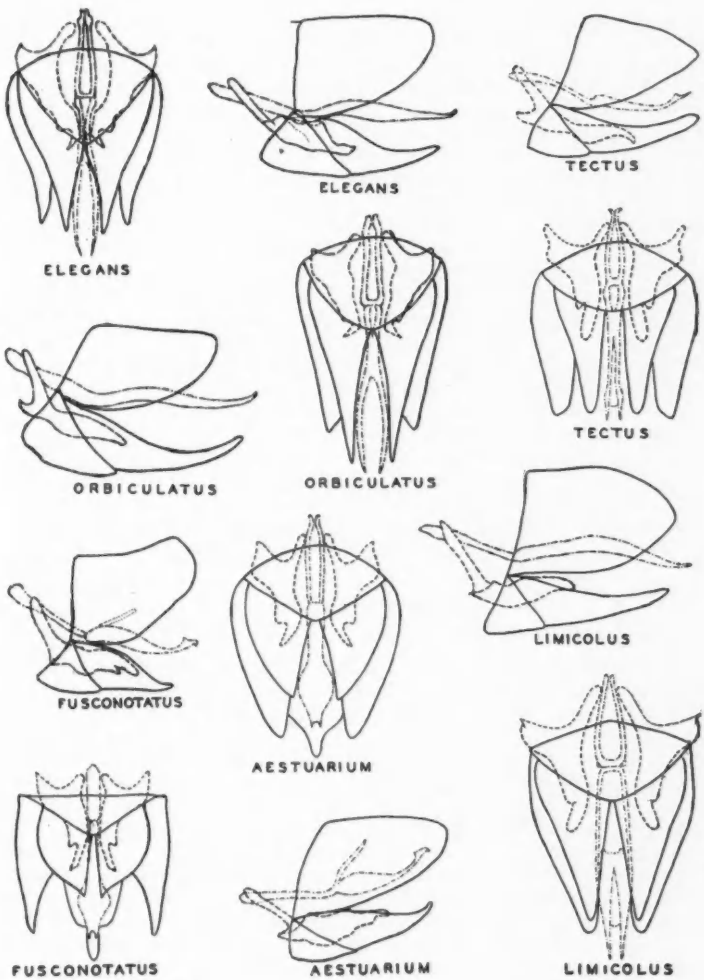
Color: Face yellow with a brown wavy line just beneath margin of vertex. Vertex, pronotum and scutellum dirty white washed with yellow or greenish yellow. Ocelli dark and a pair of minute separated spots just above apex. Elytra milky white marked as in *sanctus* with a brown cross extending from costa each side across clavus. The arms of the cross on each side are broad, pale brown and bordered with darker brown. They enclose a triangular white spot on costa and a small round white spot on clavus. A brown area also extends from apex of clavus to apical costal area enclosing the anteapical cross veins which are heavily margined with brown.

Genitalia: Female last ventral segment produced from near base to form a roundedly produced posterior margin which is slightly notched at apex. The portion of the underlying segments are exposed and plainly visible at each side. Male plates as long as pygofers, narrowed to blunt apices. Style rather broad, deeply notched on outer margin, apex broad, truncate. Aedeagus in lateral view long and narrow, in ventral view bifid on apical two-thirds, forming a pair of slender processes which are separated and converge at apices.

Holotype male and *allotype* female collected at Tuxtla, Gutierrez, Chiapas, July 29, 1936, by Dr. Dampf (M. F. 1055). Male and female *paratypes* collected at Iguala, Gro., September 11, 1939, by Plummer and DeLong and at Mainari, Son., August 11, 1927, by Dr. Dampf (M. F. 1282A).

Sanctanus elongatus n. sp.

Resembling dark specimens of *sanctus* in general appearance. With four marginal spots on vertex and with distinct male genitalia. Length 4–4.5 mm.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Vertex angularly produced, about one-sixth wider between eyes than median length.

Color: Vertex pale yellow, a pair of minute brown spots just above apex and a spot above each ocellus. Pronotum pale anteriorly, dusky posteriorly. Scutellum with two small round spots just back of pronotum. Elytra milky white with the brown cross extending from the costal margin across clavus and forming the white spot on costal margin and the spot on clavus. The cross is dark brown to black. A brown spot covers the posterior portions of the anteapical cells and the cross veins. The veins are white, margined with dark brown. Face yellow below, dusky above. A transverse brownish band just beneath antennal sockets, brownish arcs above and a narrow sinuate line just beneath margin.

Genitalia: Female last ventral segment roundedly produced from base to form a broadly rounded posterior margin which is slightly notched at middle, with a black spot on either side. Portions of the underlying membrane are exposed at each side of the lateral margins. Male plates as long as pygofer tapered to pointed apices. Style deeply notched on outer margin near apex forming a broad apical portion which is concave apically. Aedeagus in lateral view long, narrow, and curved. In ventral view bifid on apical half, the apical portions of the two processes narrowed to slender tips.

Holotype male, ***allotype*** female and male and female ***paratypes*** collected at Uruapan, Mich., Mexico, October 1, 1941, by Plummer, Caldwell, Good and DeLong; Rio Tuxpan, Mich., K-185, September 29, 1945, elevation 6,000 feet, and at Morelia, Mich., September 30, 1945, elevation 6,500 feet, by Plummer, Hershberger, Elliott and DeLong.

Sanctanus orbiculatus Ball

Sanctanus orbiculatus Ball. Jour. Wash. Acad. Sci. 22: 11, 1932.

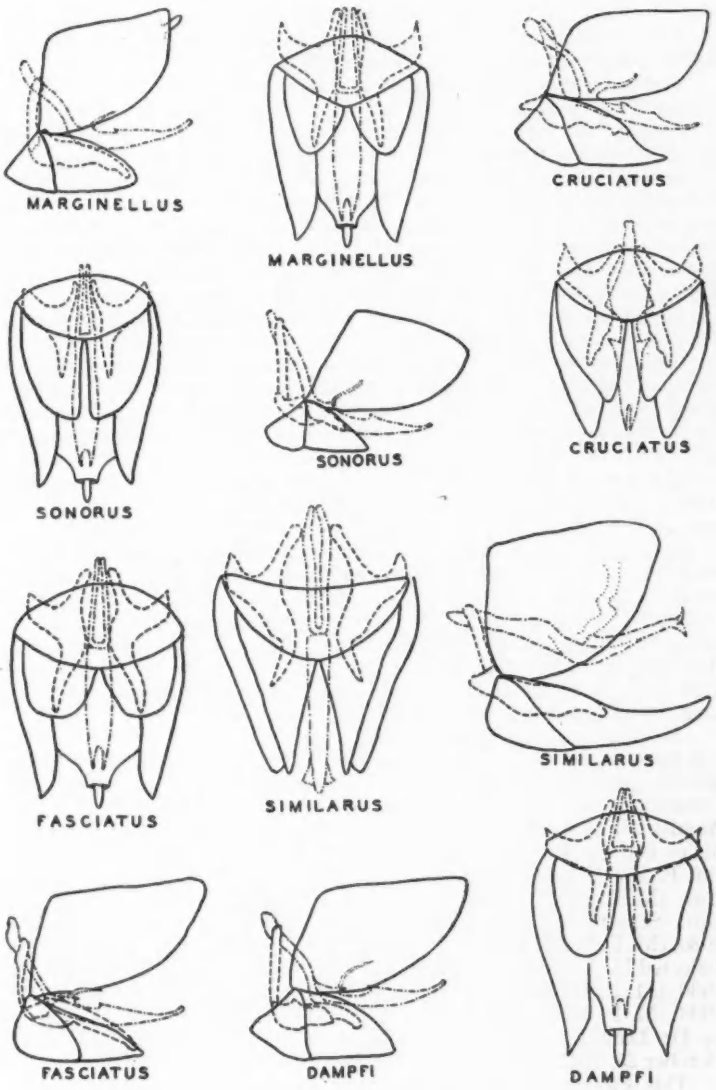
A distinctly marked species, salmon in color with white markings and four black spots on margin of vertex. Length 4–5 mm.

Vertex obtusely angled, broader than long and angled with front at apex.

Color: Vertex white, apex with a pair of spots above and a short angular line beneath. A larger pair of spots surround the ocelli and a large pair on posterior portion. Pronotum and scutellum pale in the female, salmon colored in the male. Elytra pale salmon tinted with smoky in the male, the scutellar margins broadly white in the female. There is a narrow white band across the basal portions of the anteapical cells, beyond which the nervures are white with smoky margins. The second apical cell contains a large round eye-like black spot.

Genitalia: Female last ventral segment slightly produced at middle of posterior margin, male plates long, rather slender, acutely triangular. Style rather short and broad, rather deeply notched on outer margin near apex with tip bent outwardly and sharply pointed. Aedeagus in lateral view appearing long and slender, in ventral view the apical half is bifid with the two portions curved and separated.

This species was described from the southwestern United States and is not known to occur in any other area.



Lateral and ventral views of the caudal portion of the male abdomen showing the genitalia in position for species of *Sanctanus* as labeled.

Sanctanus elegans n. sp.

Somewhat resembling *orbiculatus* but with a different color pattern and different male genitalia. Length 3.5–4.5 mm.

Vertex produced and bluntly angled, a little wider between eyes at base than median length.

Color: Face pale yellow with a narrow black band just beneath margin. Vertex white with a narrow black transverse broken band between eyes near base, the outer ends of which are curved posteriorly. Pronotum white with a black mark at middle on anterior margin, a large black spot near posterior margin just back of each eye and a minute spot near each, between them and just before posterior marking. Scutellum milky white to creamy, basal angles often a little darker. Elytra orange yellow with distinct black and white markings. There is a large black spot just beyond base of each elytron. A brown bordered white stripe extends along margin of scutellum and along suture to apex of clavus. This encloses a small spot and black line on anal portion of wing. Another brown margined white band is just anterior to apical cross veins and extends about one-third the distance to base on outer claval vein. A third white stripe extends along the inner branch of the first sector its entire length, and a fourth arises on the costal margin at the anterior end of the first anteapical cell and follows both veins to its apex. Apical cross veins white, brown banded, and apex of elytra with a broad brown margin. Beneath yellowish.

Genitalia: Female last ventral segment roundedly produced from near base to slightly concavely rounded posterior margin. The lateral portions of underlying segment visible at each side. Male plates as long as pygofer, sharply pointed. Style abruptly narrowed just before apex, forming an outwardly directed sharply pointed apical process. Aedeagus in lateral view straight, tapered to a narrow tip. In ventral view bifid, about one-third the distance from base with the two processes long, tapered and distinctly separated.

Holotype male, *allotype* female and male and female *paratypes* collected at Tierra Colorado, Gro., K-271, October 5, 1945, by Balock, Elliott, Hershberger and DeLong. *Paratype* males and females from Cutzamala, Gro., August 20, 1930 (M. F. 1768); Pungarabato, Gro., August 22, 1930 (M. F. 1769), both collected by J. Parra. *Paratype* males and females also from Coyuca-Catalon, Gro., August 24, 1930 (M. F. 1771); Yetla, Gro., August 12, 1930, (M. F. 1756); San Miguel, Gro., (M. F. 1759); Balsas, Gro., August 15, 1930 (M. F. 1754); Vejuco, Gro., September 3, 1930 (M. F. 1790); Zirandera, Gro., August 29, 1930, (M. F. 1786); Pasade Vecas, Gro., September 3, 1930 (M. F. 1792), collected by J. Parra. *Paratypes* from El Mante, Tamaul., October 26, 1930, (M. F. 1775); Yaqui Valley, Sonora; Huetamo, Mich., August 22, 1933, (M. F. 3100) and Mexico (M. F. 1773) and (M. F. 1777), collected by Dr. Dampf. *Paratypes* from Iguala, Gro., September 11, 1930, and October 25, 1941, were collected by Plummer, Good and DeLong.

This is a common meadow species occurring on herbaceous plants.

Sanctanus tectus Oman.

Sanctanus tectus Oman. Proc. Ent. Soc. Wash. 36: 75, 1934.

Resembling *Polyamia arundineus* in color pattern but apparently

related to *fasciatus* and *cruciatus* with a more angled vertex. Length 4–4.5 mm.

Vertex rather strongly produced and angled, a little wider between eyes at base than median length.

Color: Vertex pale with a pair of small black spots at the apex and a large pair, irregular in shape, on the disc near the ocelli. The large spots fused with the black band on the front. A pair of small black spots on posterior portion of vertex. Pronotum with a rectangular black spot on the anterior margin medially and an irregular spot behind each eye. Disc brownish with pale margins. Elytra with basal portions white, a fuscous spot on disc of each clavus and three fuscous spots on each costal margin. Veins pale, margined with fuscous, Face pale with three transverse black bands, one across apex of clypeus. one below the antennae and one below the margin of the vertex.

Genitalia: Last ventral segment of female truncate with a broad, blunt median tooth. Male plates elongate, triangular, rather broad basally, tapering to narrow blunt tips. Style rather broad, notched on outer margin at about one-third the distance from the apex, the sides of apical third parallel, the apex blunt. Aedeagus long and narrow, the apex bent slightly dorsally, broadened just before apex and tapered to a sharp pointed tip.

This species occurs on cane, *Arundinaria tecta*, along the southern Atlantic coast from Virginia to South Carolina.

Sanctanus limicolus (Osborn)

Deltocephalus limicolus Osborn. Fla. Ent. 6: 17, 1922.

A dark gray species with fuscous markings. Length 3.5–3.75 mm.

Vertex obtusely angled, about one-half longer at middle than next the eyes. The clavus with numerous reticulations and the anteapical cells broken by irregular cross veins.

Color: Vertex white with four fuscous dots on the anterior border, two lunate spots midway and two rounded ocellate spots on the hind border. Pronotum fuscous with five gray longitudinal stripes. Scutellum with ivory spots each side. Elytra with areoles mostly fuscous and veinlets mostly ivory white. The first apical areole black. Face pale fuscous with transverse whitish arcs.

Genitalia: Female last ventral segment with posterior margin almost truncate. Portions of the preceding segment conspicuous at the lateral margin. Male plates broad at base, rapidly narrowed to acutely upturned apices. Style rather short, slightly notched on outer margin about one-fifth the distance from apex, the apical fifth thick and blunt at tip. Aedeagus long and narrow in lateral view. In ventral view appearing bifid on apical third, the apical processes forming long, tapering, pointed apices.

This is a common tidal flat species of the Florida coast.

Sanctanus eburneus (DeLong)

Deltocephalus eburneus DeLong. Jour. N. Y. Ent. Soc. 32: 63, 1924.

A white species with few and faint markings, apparently related to *sanctus*. Length ♀, 4.5 mm.

Vertex bluntly angled, almost one-fourth wider between eyes at base than length at middle. Disc flat, rather sharply angled with front. Pronotum almost twice as broad as long. Clavus of elytra reticulate, central anteapical cell long, constricted and divided at center.

Color: Vertex white with four small pale orange spots above margin and a pale blotch on disc either side of middle. Pronotum with a broad median brownish stripe and a narrower one either side. Scutellum pale yellow with basal angles and apex darker. Elytra milky white, a large spot on middle of outer clavus dark brown, posterior claval cells washed with yellow. Inner anteapical cell, anterior and posterior portions of middle anteapical cell and outer apical cell pale to dark brown. Face, clypeus and lorae heavily embrowned with traces of pale arcs on face.

Genitalia: Female last ventral segment with posterior margin shallowly, concavely rounded.

This species was described from Mississippi, and no other records have been published to date.

Sanctanus fusconotatus (Osborn)

Deltocephalus fusconotatus Osborn. Fla. Ent. 6: 17, 1922.

White, marked with fuscous spots on pronotum, scutellum and base of elytra. Length, male, 3.5 mm.

Vertex bluntly angled, as long at middle as width between the eyes at base.

Color: White, vertex bordered anteriorly with black, except at apex, the outer part of the black line enclosing the ocelli. Pronotum with three diffuse spots, scutellum with two dots on the base. Each elytron has a small fuscous basal spot and a spot just before and just behind the merged veins. A dark spot on costa near base and another before the apical cells. Face densely black at base, clypeus and lower portion of face white.

Genitalia: Male plates small, triangular, about one-half the length of the pygofer. The styles are rather broad at the base, abruptly narrowed near the apex and produced in narrow fingerlike apices. The aedeagus in ventral view is inflated just before apex. In lateral view it appears narrow just before the apex and slightly broadened at the apex.

In type of genitalia it appears closely related to *aestuarium*.

The species is known from the type specimen only, collected at Cameron, Louisiana.

Sanctanus aestuarium (DeLong and Sleesman)

Polyamia aestuarium DeLong and Sleesman. Anns. Ent. Soc. Amer. 22: 101, 1929.

Superficially resembling *P. arundineus* in general coloration. Apparently allied to *limicolus*. Length 4 mm.

Vertex rather broad, produced, slightly wider between eyes than length at middle, flat or slightly depressed on disc. Central anteapical cell constricted and divided.

Color: Pale yellow, a pair of oblique orange bands extending from the margin of the vertex to the central posterior portion of the disc.

Pronotum with a large orange spot along anterior margin extending between the eyes, and a large round spot on central portion of pronotum behind either eye. Basal angles of scutellum orange. Elytra orange yellow, veins milk-white and heavily infuscated at certain places. A large spot on the costal margin at about its middle, discal, central anteapical and apical cells fuscous. Face black above, the coloration extending obliquely beneath the eyes.

Genitalia: Female last ventral segment rather short on lateral margins, then produced to form a broad trilobate posterior margin, only a slight notch occurs either side of central lobe, but the coloration causes it to appear decidedly trilobate. Lateral portions of underlying segment produced beyond last ventral segment at either side. Male plates short, strongly convexly rounded to pointed apices. Style elongate, rather deeply notched on outer margin near apex, the apical fifth narrow, finger-like, tip rather sharply angled. Aedeagus in lateral view bulbous at base, strongly narrowed then slightly enlarged at apex. In ventral view it is narrowed on basal half, the apical half convexly rounded and broadened, then narrowed to narrow blunt apex.

This species occurs in the tidal salt marsh of the lower Atlantic coastal area. It was originally described from North Carolina.

Sanctanus fasciatus (Osborn)

Scaphoideus fasciatus Osborn. Jl. Cinc. Soc. Nat. Hist. 19: 190, 1900.

A broad-headed species with a blunt vertex. Length 4 mm.

Vertex about one-third wider between eyes at base than median length, anterior margin produced and rounded.

Color: Vertex pale with two dark points just above apex and two paler transverse spots between anterior margins of eyes. Face pale, two marginal bands just below margin, also two dark bands, one across face just beneath eyes and another across clypeus. Pronotum with a dark spot behind each eye on anterior margin. Scutellum pale with a dark spot in each basal angle. Elytra when closed in normal position with a brown cruciate band extending from anterior costal margin to and along commissure to apex. The outer margin is bordered with dark brown. The white base of the clavus parallels the edge of the scutellum, and a white bar crosses the clavus obliquely near the tip.

Genitalia: Female last ventral segment concavely excavated. Male plates broader than long, broadly rounded, reaching to about the same length as the apex of styles. The apical half of the style is narrowed, produced and tapered to a blunt apex. The aedeagus in lateral view is narrowed on the apical fourth to form a slender apex. There is a broad shallow excavation on the dorsal margin. In ventral view the aedeagus is deeply roundedly notched at the apex, forming a pair of separated apical teeth.

This species was originally described from specimens collected at Port au Prince, Haiti, and Frontera, Mexico. It is apparently a rather common species in Mexico and has been collected at Valles, S. L. P., September 25, 1941; Tehuantepec, Oax., October 13, 1941, and Iguala, Gro., September 11, 1939, by Plummer, Caldwell, Good and DeLong.

Sanctanus marginellus n. sp.

A rather broad-headed species with blunt vertex resembling *fasciatus*, but elytra with a more general brownish color. Length 4 mm.

Vertex about one-third wider between eyes at base than median length, anterior margin produced and rounded.

Color: Creamy white, vertex with a brown spot above ocellus next each eye and two elongated dark brown spots almost contiguous extending from ocellus almost to apex just above margin. There is paler brown mottling either side of a median paler stripe. Pronotum pale brown with irregular white spots along anterior margin behind each eye. Scutellum dull brown. Elytra pale brown, subhyaline, with dark and pale areas similar to *fasciatus*. The markings are not intensified and blend more nearly with the coloration of the elytron. Face pale with the transverse band between the antennal pits and two conspicuous transverse bands beneath the margin of vertex.

Genitalia: Female last ventral segment rather shallowly concavely excavated between produced lateral angles and either side of a short blunt median tooth. Male plates broader than long, broadly rounded, about as long as apices of styles. Style with apical half narrowed, produced, tapered to a blunt apex. Aedeagus in lateral view narrowed to form a slender apex on apical fourth. There is a broad shallow excavation near base on dorsal margin with a short basal spur extending dorsally. In ventral view the aedeagus is deeply roundedly notched at apex forming a pair of separated apical teeth.

Holotype male, *allotype* female and female *paratypes* collected at Cantetul, Guat., December 11, 1925, (M. F. 878), by Dr. Dampf.

Sanctanus cruciatus (Osborn)

Scaphoideus cruciatus Osb. Ohio Nat. 11: 253, 1914.

Resembling *fasciatus* in general appearance but with the vertex a little more produced and male plates more triangular in shape. Length 4.5 mm.

Vertex broadly, bluntly produced, more than one-third wider between eyes at base than median length.

Color: White, tinted with yellow. The vertex has two transverse brown spots just in front of the middle, with two minute black spots close to the eyes at base. Face with a distinct bar from lower border of eyes crossing below the antennae and a broader black band across the clypeus, enclosing lower half of the lorae and apex of clypeus. Elytra bearing the usual cruciate brown mark which is distinctly dark margined. Anteapical cells brown, bordered with black, their veins white. First and second anteapical cells usually black, third usually light, veins white.

Genitalia: Female last ventral segment with posterior margin concavely roundedly produced to form a rather broad rounded median tooth. Margin narrowly embrowned. Male plates broad at base, convexly rounded to rather blunt apices. Style rather broad at base, abruptly narrowed at about middle to form a long slender finger-like apical portion which is narrowed and blunt at apex. Aedeagus in ventral view rather narrow at base then broadened to form a tooth on each outer

margin from which the aedeagus is tapered to a pointed apex either side of a rather deep median incision. In lateral view it bears a dorsal spur near base and a conspicuous notch on dorsal margin just before middle.

The species was described from a specimen collected at Cold Springs Harbor, Long Island, N. Y. It has since been collected farther south along the Atlantic coast.

Sanctanus dampfi n. sp.

Resembling *fasciatus* in coloration and general appearance but with male plates more narrowed and elongated, apices greatly exceeding styles. Length 4.5 to 5 mm.

Vertex bluntly produced, rounded at apex, about one-third wider between eyes at base than median length.

Color: Vertex white, with two small brown proximal dots near apex and two transverse fuscous spots halfway between base and apex. Face pale with two brownish transverse bands just beneath vertex margin and a conspicuous band between the antennal pits. Pronotum pale with brownish mottling. Scutellum white, basal angles dark. Elytra with the fuscous cruciate mark across clavus, the posterior bars extend only to the middle of the disc. A fuscous band extends from this point to suture at apex of clavus. The cross is bordered with dark fuscous. A white band crosses the clavus obliquely near tip and the hyaline discal and apical spots are bordered with white.

Genitalia: Female last ventral segment concavely excavated with a slightly produced portion at apex. Male plates about one-fourth longer than basal width, broadly rounded at apex, decidedly longer than style. The style is broad basally, the apical half is narrow and sharp pointed apically. The aedeagus in lateral view is gradually narrowed to apical fourth which is slender. In ventral view the apex is rather deeply, roundedly notched forming a pair of separated, pointed, apical teeth.

Holotype male collected at Chiapa de Corza, Chiapas, July 26, 1926 (M. F. 1047). *Allotype* female taken at Reforma, Tab., June 21, 1938 (M. F. 6674). *Paratype* males from Pocviene, Tab., December 31, 1938 (M. F. 8215), and at Zapota, Tab., July, 1938 (M. F. 6859), all collected by Dr. Dampf.

Sanctanus sonorus n. sp.

Resembling *cruciatus* in general appearance but with vertex more strongly produced and with male genitalia distinct. Length 4.5 mm.

Vertex strongly produced, about one-fifth wider between eyes than median length, bluntly angled at apex, tip rounded.

Color: Vertex white with faint markings consisting of a proximal pair of faint brown points at apex and two faint brown transverse spots between the anterior margins of the eyes. Pronotum white, the posterior discal portion darker. A small brown spot just back of each eye on anterior margin. Scutellum white with brown spots in basal angles. Elytra pale with a brown cruciate mark resembling that of *fasciatus*, the posterior brown bars extend only to the disc, and the brown band extends to the suture at apex of clavus. A parallel band of white extends

along scutellum on base of elytron. The anterior apical cells are dark brown, the posterior apical cells are white, bordered with brown.

Genitalia: Female last ventral segment broadly shallowly excavated with a slightly produced, blunt tooth at middle. Male plates a little longer than basal width, broadly convexly rounded on outer margins to inner margin which is straight. Styles broad basally, tapered to pointed apices. Aedeagus broadly shallowly excavated on dorsal margin with a basal dorsally directed spur, aedeagus gradually tapered to a narrow apex. In ventral view the apex is rather deeply roundedly notched, forming a pair of separated pointed apical teeth.

Holotype male, *allotype* female and male and female *paratypes* collected at Mainari, Son., August 11, 1927 (M. F. 1282A). *Paratype* males and females collected at Yaqui Valley, Sonora, August 16, 1927 (M. F. 1285), and at Cuautla, Mor., August 27, 1937 (M. F. 6247). All material was collected by Dr. Alphonse Dampf.

Sanctanus virgatus n. sp.

In general form resembling *fasciatus* but with distinct coloration in the form of transverse bands on the vertex and pronotum and longitudinal stripes on the elytra. Length 4.5 mm.

Vertex broad, blunt at apex, scarcely angled, almost one-third wider between eyes than median length. Elytra long.

Color: Vertex with a pair of minute separated brown spots just back of apex, an oblique line just above each ocellus on margin, a broad transverse band on median half before anterior margins of eyes and a rather broad transverse band just before basal margin. Pronotum with two broad transverse brown bands, one just back of anterior margin and another just before posterior margin. A large brown triangular spot on each basal angle. Elytra dark brown to black with the veins rather broadly white, giving a striped appearance. There is a conspicuous white curved area on the corium and a curved oblique band extending from apex of clavus to costal margin. The posterior third of the elytron is pale brown to white with the veins rather heavily dark margined. Face with a broad black transverse band just beneath antennae and ventral margins of the eyes. A series of fused black arcs form a second transverse band between the eyes and a third narrow black band is just beneath the ocelli and beneath the margin of vertex.

Genitalia: Female last ventral segment produced from lateral margins to a truncate apex with a short median produced embrowned tooth. Portions of the underlying segment are visible at either side.

Holotype female collected at Tehuantepec, Oax., October 13, 1941, by Good, Plummer, Caldwell and DeLong. Female *paratypes* were collected at Piedras Negras, Vera Cruz, September 17, 1926, by Dr. Dampf (M. F. 1077).

PARASITIZATION OF THE ORIENTAL MOTH (CNIDOCAMPA FLAVESCENS (WALK.)) BY CHAETEXORISTA JAVANA B. AND B.

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During 1929 and 1930 the larvivorid (tachinid) fly *Chaetexorista javana* B. and B. was successfully introduced from Japan into the United States as a parasite of the oriental moth (*Cnidocampa flavescens* (Walk.)). The oriental moth has a very restricted distribution in this country, occurring, so far as is known, only in the vicinity of Boston, Mass. Because of the restricted range of the host and the fact that attack by other parasites is practically negligible, it has been possible to follow the history of the parasite in its new environment more closely than is usually the case with an introduced species. This paper is a record of the proportion of host larvae parasitized from 1930 through 1942, with some observations regarding the factors responsible for fluctuations in percentage of parasitization.

HISTORY, DISPERSION AND HABITS OF THE ORIENTAL MOTH IN THE UNITED STATES

The early history of the oriental moth in the United States may be briefly summarized from publications by Fernald (6,) (7). The insect was first observed in the Dorchester section of Boston, Mass., in 1906. Since it is an oriental species prevalent in Japan, the proximity of the place of discovery to a former nursery which handled Japanese plants suggests that it probably was imported on nursery stock. Although the insect was abundant at the apparent center of distribution, only about 3 square miles were determined as infested in 1906. In 1916 about 12 square miles were known to be infested. The limits of dispersion in 1942 are shown in figure 1. Approximately 300 square miles are included in the infested area.

Larvae of the oriental moth feed on the foliage of a wide variety of trees. Norway maple is preferred, but pear, apple, cherry, plum, black birch, and sycamore maple are often fed on extensively. The larvae may also develop on a number of other plants. Infested trees are only slightly injured, for defoliation does not usually occur before

[1]This study was conducted at New Haven, Conn., under the direction of R. C. Brown. A number of workers have been engaged on different phases of the problem. P. A. Berry collected cocoons and made dissections at Melrose Highlands, Mass., and New Haven, Conn., from 1932 through 1937. J. V. Schaffner, Jr., and C. L. Griswold made many observations on the life history of *Cnidocampa*, and R. T. Webber made many of the early dissections at Melrose Highlands. Since 1937 the Massachusetts Department of Conservation, particularly through the work of M. H. Donovan, has collected a number of the cocoons. F. M. Wadley, of the Bureau of Entomology and Plant Quarantine, gave helpful advice on the statistical phases of the problem.

late in September. Nevertheless, the larvae are a considerable nuisance, because their spines cause a nettlelike poisoning or irritation when they come in contact with a person's skin.

The moth completes one generation each year. It spends the winter as a prepupa within a hard-shelled, oval cocoon, which is firmly attached to a twig or branch of its food plant. Pupation takes place about the first of May, and adult moths are present in the field from the latter part of June until late in July. The moths are nocturnal in

FIGURE 1. Map of Boston, Mass., and vicinity, showing known distribution of *Cnidocampa flavescens* (Walk.) (enclosed by double dotted line) in the United States. The point of original discovery at Dorchester in 1906 is indicated by X. Insert, the State of Massachusetts showing the relative size of the infested area.

habit, and apparently fly no great distance. The eggs hatch in about a week. The larvae, like other Limacodidae, are sluglike, slow-moving caterpillars and seldom wander far from their original food plant. Some larvae become full fed and spin their cocoons as early as August, but the greater number spin them late in September.

Cnidocampa flavescens is widely distributed in the Orient, having

been found from about the 50th parallel in southern Siberia to the 30th parallel somewhat south of Shanghai, in China. A comparable area in North America would include southern Canada and all of the United States except the southern parts of Florida and Texas.

Dispersion of the moth in the United States has been surprisingly slow. The rather sedentary habits of both moths and larvae only partially explain why this species has not become more widespread. Certainly its ability to develop on a great variety of common food plants and its tolerance to wide variations in climate, as evidenced by its distribution in the Orient, would indicate a potential distribution far in excess of the maximum distance of 25 to 30 miles which it has spread during the 40 years that it is known to have been present in this country. Dyar (5) even made an attempt, fortunately unsuccessful, to establish the species in Washington, D. C. Even if this insect becomes far more widespread in the future, its originally slow dispersion must rank as one more of the unpredictable features of insect behavior with which the entomologist is continually confronted.

INTRODUCTION AND ESTABLISHMENT OF CHAETEXORISTA JAVANA

The introduction and establishment of *Chaetexorista javana* in this country and the rapidity with which the species subsequently parasitized a large proportion of the host population has been well summarized by Collins (3). In 1928 arrangements were made with T. R. Gardner, of the Bureau of Entomology, then engaged in the collection of Japanese beetle (*Popillia japonica* (Newm.)) parasites in Japan, to ship overwintering cocoons of *Cnidocampa flavescens* to the forest-insect laboratory at Melrose Highlands, Mass. About 30,000 cocoons were shipped to this country in the spring of 1929 and about 779,000 in 1930. The entire 1929 shipment and 485,000 cocoons of those obtained in 1930 were collected at Fuji, Japan, and the remainder were collected at Aikawa, Japan. The material in these shipments produced a total of 6,190 *Chaetexorista* adults in 1929 and 86,711 in 1930.

The rather simple life history of the parasite made its importation a comparatively easy problem. *Chaetexorista javana* is a large larvivorid fly, which completes a single generation each year. It overwinters as a second-instar larva within the hibernating *Cnidocampa* prepupa. Development is completed early in the summer, and the puparium is formed within the host cocoon. The adult parasite emerges by pushing off the cap at the end of the host cocoon, which normally serves as an exit for the adult moth. The female fly deposits a large egg on the integument of the host larva. Upon hatching the young maggot bores into the body of the larva, attaching itself by means of an integumental funnel. Only one parasite develops to maturity in a host larva.

At the Melrose Highlands laboratory the *Cnidocampa* cocoons were held in cardboard boxes. Separation of the emerging moths and flies was facilitated by the fact that the moths normally emerge at night and the flies during the daytime. The flies, as they emerged, were put in large cloth-covered cages for transportation to the 16 liberation points scattered throughout the infested area.

RECORD OF PARASITIZATION IN THE UNITED STATES

An attempt to collect oriental moth cocoons was made every year from 1930 through 1942, except in 1935, at each of the 16 original *Chaetexorista* liberation points. When practicable, 200 cocoons were collected at a point. Frequently none and often considerably fewer than 200 cocoons were obtained. In Quincy and at 2 points in the southern and western outskirts of Boston (Neponset and Jamaica Plain) no cocoons could be found after 1932. At 4 other points (South Boston, Dorchester (at Pope's Hill), Saugus, and Everett) collections have been small and intermittent. It has been possible, however, to get the full 200 cocoons almost every year at the other 9 points (Dorchester (at Columbia Road,) Cambridge, Medford, Chelsea, Winthrop, Nahant, and 3 points in Revere), and 83 per cent of the total of 18,033 cocoons were obtained at these 9 points. All the cocoons were opened at the laboratory, and the prepupae were dissected to determine whether or not they were parasitized.

Figure 2 shows the percentage of parasitization of all cocoons collected each year. These figures approximate closely those for the 9 points where most of the cocoons were collected. The largest proportion of cocoons were parasitized in 1933, when 63.5 per cent contained *Chaetexorista* larvae. This figure was nearly equaled in 1940, when 58.9 per cent were parasitized.

The significance of the variation in percentage of parasitization at the 9 collection points, where most of the cocoons were collected, was determined by an analysis of variance of data obtained during the 11-year period 1930–40. No collections were made in 1935, and at several points no collections were made in 1941; so these 2 years were omitted from the calculations. The analysis showed significant, but not highly significant, variation between percentages of parasitization at the collection points. Further analysis showed that the significant variation was due to data from 3 points, namely, Cambridge, Nahant, and one point in Revere. The average percentage of parasitization for these three points was 27.76, whereas for the other six points it was 37.73 Reasons for the variation indicated are too difficult to interpret with the limited knowledge available. There certainly seem to be no geographical or ecological differences between these points and the others. Nahant might be considered somewhat removed, but the three collection points in Revere are hardly 2 miles apart, and there seems to be no apparent reason why one should vary significantly from the other. From a practical standpoint it is probably advisable to think of *Chaetexorista* as destroying about the same proportion of its host population throughout the entire area represented by the 9 collection points.

In addition to the cocoons collected at the original *Chaetexorista* liberation points, a number of collections made by the Massachusetts Department of Conservation were also dissected. In 1939 a total of 2,490 cocoons from 31 collection points proved to be 19.9 per cent parasitized by *Chaetexorista*. The next season 2,043 cocoons were collected, principally from 2 localities. Of these, 39.9 per cent were parasitized. There were 2,893 cocoons collected at 6 points in 1941, and

57.5 per cent were parasitized. These figures are interesting when compared with the parasitization at the *Chaetexorista* liberation points, which were 52.4, 58.9, and 53.9 per cent in 1939, 1940, and 1941, respectively. Two possible explanations for the lower figures of the Conservation Department collections in 1939 and 1940 seem worth considering. In the first place most of these collections were made on the outskirts of the infested area, where it is probable that *Chaetexorista* had not been of general occurrence over a long period; and secondly, many of the collections were made in what appeared to be rather sudden, heavy outbreaks of *Cnidocampa*. In general, the lighter infestations in 1939 had a larger proportion of parasitized cocoons.

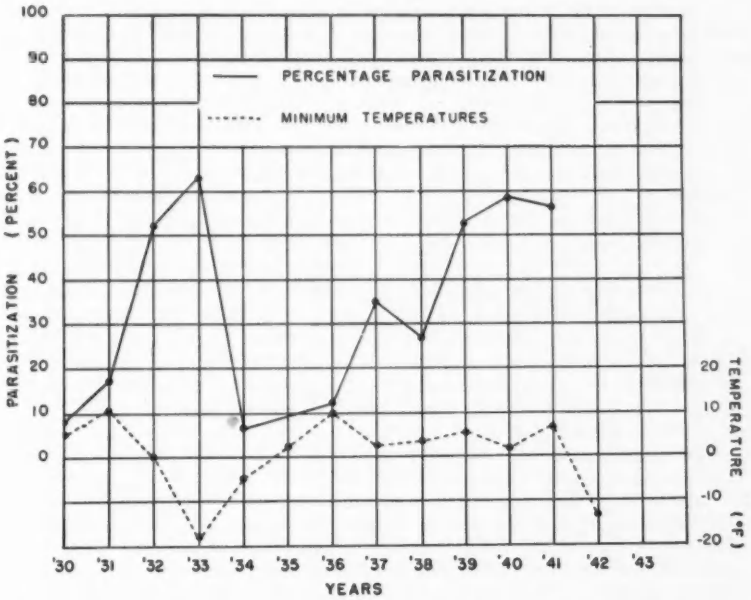

FIGURE 2. Combined percentage of parasitization of prepupae of *Cnidocampa flavescens* in 16 collection points by *Chaetexorista javana* during the years 1930–41, and minimum official temperatures recorded at Boston, Mass., 1930–42. (The minimum temperature noted for any year actually refers to the winter beginning in that year, as 1930–31.)

EFFECT OF SUBZERO TEMPERATURES ON CHAETEXORISTA AND CNIDOCAMPA

Figure 2, showing the parasitization at the *Chaetexorista* liberation points, also shows the minimum official temperatures recorded at Boston, Mass. As with the insect records, the minimum temperature for any year actually refers to the winter beginning in that year, for example, the winter of 1930–31. The minimum temperature has been

recorded in this manner to correspond with the year the *Cnidocampa* cocoons were formed and parasitization by *Chaetexorista* took place. The very sudden drop in parasitization in 1934 was undoubtedly caused by the exceptionally low temperatures in the winter of 1933. In fact, all parasitized prepupae dissected in the spring of 1934 contained dead *Chaetexorista* larvae.[2] Of course, some *Chaetexorista* larvae survived; otherwise the species would not have been capable of parasitizing 11.4 per cent of the cocoons collected in 1936. Nevertheless, the killing was so widespread that no survivors were observed in material dissected that spring. Through a succession of comparatively mild winters, following 1934, the proportion of cocoons parasitized by *Chaetexorista* increased rather rapidly until 1940, when it was almost 60 per cent. The winter of 1942, however, was exceptionally cold, and a minimum temperature of —14° F. was recorded at Boston. About 200 cocoons each were collected at Cambridge, Chelsea, and one point in Revere in the spring of 1943. Dissections showed 369 hibernating second-instar *Chaetexorista* in the 601 prepupae examined, and all the parasites were dead. Another sharp drop in parasitization was therefore expected in 1943.

A considerable amount of experimentation was conducted under laboratory conditions to determine what temperatures were lethal to the hibernating parasites. Small lots of *Cnidocampa* cocoons, some of which had been conditioned by outdoor temperatures, were exposed to 0°, —5°, and —10° F. for 24 hours.[3] Temperatures of 0° did not affect the hibernating *Chaetexorista* larvae, whereas −5° killed about 80 percent and —10° killed all of them. One lot of cocoons was also exposed outdoors to a short, sudden drop in temperature to —6°. About half the parasites were killed. Check lots of cocoons held in the laboratory all winter at 36° consistently showed no mortality of hibernating parasites when dissected in May, and check lots brought in from the field at various times in the winter and held at 36° until dissected in May consistently showed no increase in *Chaetexorista* mortality after the cocoons were brought into the laboratory.

There is no doubt that temperatures between 0° and —5° F. kill a high percentage of *Chaetexorista* larvae. It is not so clear, however, whether or not higher temperatures under certain conditions, or other unknown factors, may kill them. Records from field-collected cocoons formed in 1938, 1939, 1940, and 1941 showed high mortality of *Chaetexorista* larvae, and yet the official minimum temperature recorded in Boston for these four winters was 2°. The most complete records for any one year were those obtained for cocoons formed in 1941. These cocoons were collected by the Massachusetts Department of Conserva-

[2]Throughout this discussion reference to dead *Chaetexorista* larvae refers only to dead second-instar maggots. Although several *Chaetexorista* larvae may enter a *Cnidocampa* larva, only one can complete its development, and seldom does more than one reach the second instar, or hibernating stage.

[3]Experiments to determine the effects of exposure to cold were carried on at the Connecticut Agricultural Experiment Station through the courtesy and help of Raimon L. Beard. Cocoons were collected at different times during the winter and exposed in lots of 50 for 24 hours. A thermocouple was inserted inside one cocoon in each lot; therefore, the temperatures referred to actually represent the temperature inside the cocoons.

tion on three different dates at approximately the same locations in Beverly, Revere, Salem, and Winthrop. That winter a minimum official temperature of 7° was recorded in Boston on December 21. Nevertheless, collections in April showed that 90 per cent of the *Chaetexorista* larvae were dead. The data on these dissections are summarized in Table I.

TABLE I

MORTALITY OF HIBERNATING *Chaetexorista javana* DURING THE WINTER OF 1941–42 IN THE VICINITY OF BOSTON, MASS.

Date of Collection	Month of Dissection	Living Prepupae Containing			Parasitization	Parasites Present	
		No Parasites	Living Parasites	Dead Parasites		Living	Dead
		Number	*Number*	*Number*	*Percent*	*Percent*	*Percent*
BEVERLY							
Nov. 28	Nov.	83	17	0	17.0	100	0
	May[1]	20	4	0	16.7	100	0
Jan. 20	Jan.	68	8	21	29.9	27.6	72.4
	May[1]	75	9	15	24.2	37.5	62.5
April 7	April	71	0	20	22.0	0	100
REVERE							
Nov. 27	Nov.	78	20	2	22.0	90.9	9.1
	May[1]	24	6	0	20.0	100	0
Jan 19	Jan.	60	18	10	31.8	64.3	35.7
April 7	April	67	2	11	16.2	15.4	84.6
SALEM							
Dec. 1	Dec.	89	11	0	11.0	100	0
	May[1]	31	7	1	20.5	87.5	12.5
Jan. 21	Jan.	68	2	19	23.6	9.5	90.5
Feb. 9	Feb.	64	1	26	29.7	3.7	96.3
April 7	April	73	2	18	21.5	10.0	90.0
WINTHROP							
Nov. 27	Nov.	85	13	1	14.1	92.9	7.1
	May[1]	31	5	0	13.9	100	0
Jan. 21	Jan.	68	11	6	20.0	64.7	35.3
	May[1]	85	6	5	11.5	54.5	45.5
April 7	April	67	3	12	18.3	20.0	80.0

[1]Held in the laboratory at 36° F. from the date of collection to date of dissection.

The data in Table I show clearly that the mortality of *Chaetexorista* increased at the collection points during the winter of 1941–42, but that no increase in mortality took place in cocoons brought into the laboratory in November and held at 36° F. until May. Since the minimum temperature for Boston that winter was 7°, it was apparent that higher temperatures than those required to kill *Chaetexorista* by short exposures in the laboratory may cause high mortality in the field. The sudden fluctuations or the longer duration of the higher outdoor temperatures

appeared to be responsible, but no laboratory experimentation along this line has been attempted. Some other factor may have been present, but survival of *Chaetexorista* in cocoons brought into the laboratory seemed to preclude this possibility.

Another possibility is that the official minimum temperatures recorded for Boston did not represent the actual minimum temperatures at the collection points, notwithstanding the close proximity of these points to the station. In order to check further, a maximum-minimum thermometer was set up at Revere, and minimum readings were compared with those taken at Boston from December 23, 1942, to March 15, 1943. Readings at Revere were consistently lower than those at Boston, but seldom were the two sets of readings more than 3° or 4° apart, and the minimum for the period of —14° was the same at both locations. The mean daily minimum for the period was 22.5° at Boston and 20.5° at Revere.

Somewhat confusing but nevertheless of considerable interest was the rather steady increase in the proportion of hibernating *Chaetexorista* larvae that died during the winters of 1939, 1940, and 1941. Collections of overwintering cocoons in each of these years in April at the 16 *Chaetexorista* liberation points were found to contain, respectively, the following number of parasitized prepupae: 1,077, 607, and 561. The proportions of dead *Chaetexorista* for the respective years were 22.5, 59.6, and 78.6 per cent. The same tendency was noted in collections made by the Massachusetts Department of Conservation at 4 points (Revere, Winthrop, Salem, and Beverly) in 1940 and 1941.

A *Cnidocampa* prepupa containing a hibernating *Chaetexorista* larva dies, whether the parasite lives or not. The hibernating parasite is a large maggot, and if it dies the host is incapable of sloughing it off and transforming to the adult stage. In April, 1941, cocoons from four locations were separated into two lots—one lot of 463, the other of 464. The first lot was dissected, and the other was reared. The dissected lot had 198 parasite-free prepupae, 52 prepupae that contained living parasites, 184 prepupae that contained dead parasites, and 29 cocoons that had been formed in a previous season. The reared lot produced 196 moths and 52 adult parasites. An examination of the unemerged cocoons showed that 169 dead *Cnidocampa* contained dead *Chaetexorista*, 22 dead *Cnidocampa* had died from an undetermined cause, 6 *Cnidocampa* were still alive, and 19 cocoons had been formed in a previous season.

Overwintering *Cnidocampa* prepupae can withstand far lower temperatures than can the parasites. A good test of the cold-hardiness of *Cnidocampa* was provided during the winter of 1942–43, when official temperatures within a few feet of exposed cocoons went as low as —18° F. in December, —24° in February, and —6° in March. Adult emergence from unparasitized cocoons in three exposed lots comprising 410 cocoons was unaffected, but in parasitized cocoons all *Chaetexorista* maggots and *Cnidocampa* prepupae were killed. Lethal low temperatures for hibernating *Cnidocampa* have not been determined, but apparently they will survive any temperatures likely to be encountered in the vicinity of Boston.

RELATION BETWEEN OVIPOSITION OF CHAETEXORISTA AND PROPORTION OF CNIDOCAMPA PREPUPAE EFFECTIVELY PARASITIZED

Chaetexorista javana lays an external, macrotype egg. Upon hatching, the parasite larva bores through the skin of its host. The larva is fastened within the body cavity by an integumental funnel, which is usually formed some distance from the eggshell. Eggshells laid on the penultimate larval instar are molted off with the larval skin. A large proportion of the eggs are deposited on full-grown larvae and undoubtedly some eggshells are rubbed off, but most of them remain attached to the skins of the prepupae.

It is a simple matter to record the number of shells present when dissections are made. Such a record was kept for 10,022 prepupae dissected from 65 collections of cocoons during 1939, 1940, and 1941. In these collections 4,606 *Cnidocampa* prepupae contained *Chaetexorista* larvae and all but 469 bore at least 1 eggshell. It is therefore believed that records made of the number of eggshells found on each prepupa offer valuable data regarding (1) the relation between the number of eggs laid and the proportion of prepupae parasitized; (2) the proportion of eggs that may be considered wasted, since only 1 parasite can develop per host larva; and (3) the searching ability and discriminatory powers of the adult female *Chaetexorista*, as indicated by the number and distribution of eggs deposited.

In calculating the relation between the number of eggs laid and the proportion of prepupae parasitized, it has been considered advisable to plot the percentage of parasitization for each collection of cocoons against the mean number of eggshells actually found on all the prepupae in that collection, including also in the number some prepupae that contained parasites but upon which no eggshells were found.

There was a highly significant correlation ($r=0.84$) between the percentage of parasitization and the mean number of eggs deposited per host larva in the 65 collections. Variations in the mean number of eggs accounted for 70.56 per cent of the variation in percentage of parasitization. This relationship is shown graphically in figure 3.

The curve is the graph of the regression ($E=66.14 \log x + 41.14$) of the percentage of parasitization on the logarithm of the mean number of eggs in each collection. The curve has an error of estimate of 8.72 per cent. It shows clearly the rapid increase in the percentage of parasitization as the average number of eggs deposited per host larva increased. Approximately 41 per cent parasitization occurred when an average of 1 egg was deposited per host larva, and approximately 61, 73, and 81 per cent parasitization when averages of 2, 3, and 4 eggs, respectively, were deposited per host larva. A parasitization of 60 per cent, for instance, reflects a parasite population so high in relation to that of the host that the female parasites find at least 60 per cent of the host larvae and lay an average of 2 eggs per larva on the entire population.

It would seem that the parasite population would have to be relatively high to do this. In 1933 and again in 1940 and 1941 between 54 and 63 per cent of the prepupae at 16 *Chaetexorista* liberation points were parasitized. Unfortunately, low temperatures reduced the

Chaetexorista population to a very low level in 1934 and again in 1942. The writer doubts that, had low temperatures not interfered, much higher parasitization in 1935 and 1943 could have been expected over such a wide area unless some factor not affecting *Chaetexorista* greatly reduced the *Cnidocampa* population before the parasite eggs were

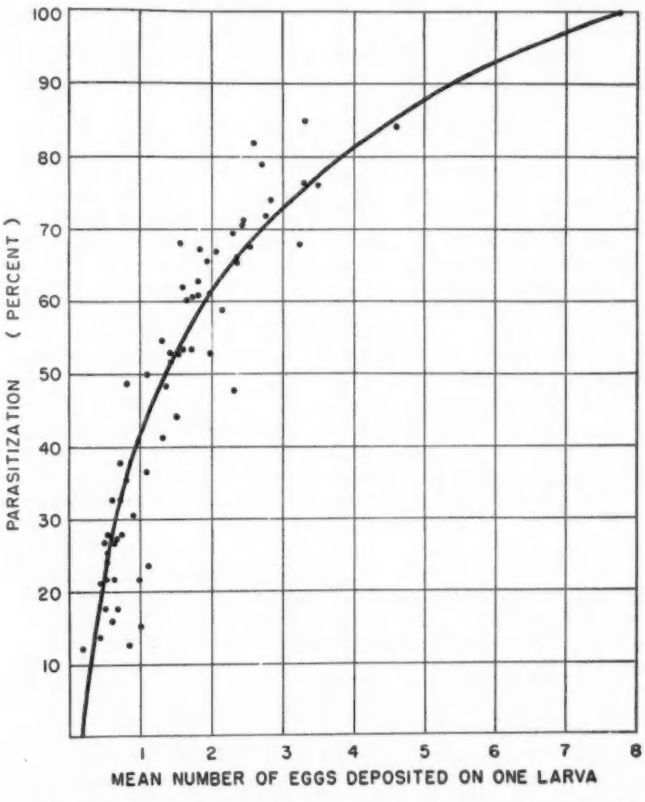

FIGURE 3. Correlation between the percentage of parasitization of *Cnidocampa* prepupae and the mean number of *Chaetexorista* eggs deposited on each host larva in 65 collections. Dots denote individual collections.

deposited. This opinion is substantiated, not only by the fact that the relative abundance of the parasite would have to increase rapidly as the parasitization increased above 60 per cent, but also, to a certain extent, by field observations. At 3 collection points, each of which is a small isolated area comprising less than an acre, the host population remained fairly constant from 1938 through 1941. Parasitization at

these points fluctuated between 51 and 69 per cent, but never went higher, although at 1 point it dropped to 39 per cent for 1 year.

Quantitative data regarding host density at these 3 collection points are lacking, but these figures seem to indicate that the proportion of hosts parasitized had approached a fixed rate in the manner described by De Bach and Smith (4) for ***Mormoniella vitripennis*** (Walk.) and ***Muscidifurax raptor*** Gir. The total parasitization at the 16 collection points in 1939, 1940, and 1941 also seems to offer some support for this belief, for parasitization was 52 per cent in 1939 and 59 per cent in 1940, but it dropped back to 54 per cent in 1941.

In 1932 sample lots of ***Cnidocampa*** cocoons imported from Japan were dissected. A total of 514 cocoons from Fuji proved to be 18.87 per cent parasitized. The prepupae bore a mean number of 0.31 ***Chaetexorista*** egg. Of 576 cocoons from Aikawa 20.31 per cent were parasitized, and the prepupae bore a mean number of 0.36 ***Chaetexorista*** egg. These percentages are similar and the mean numbers of eggs in the collections lie close to the curve shown in figure 3.

Calculations regarding the proportion of ***Chaetexorista*** eggs that may be considered as ineffective or wasted because they failed to produce a hibernating parasite larva were based on the fact that only 1 ***Chaetexorista*** can complete its development in a ***Cnidocampa*** prepupa. However, ineffectiveness is caused, not only by a duplication of egg deposition, but also by a natural mortality due to poor viability of eggs, improper placement on host integument, inability of the parasite larva to establish itself in its host, and other causes.

An estimate of natural mortality from all collections was obtained by determining from the prepupae that bore only 1 eggshell the proportion that failed to contain a hibernating ***Chaetexorista*** larva. For 1939 and 1940 this proportion was similar for all collections, averaging 26.6 ± 1.37 per cent. In 1941, however, this proportion was 53.8 ± 4.22 per cent. The reasons for such a wide difference are obscure. In 1941, of the 20 collections, 14 were made in 4 towns—Beverly, Salem, Revere, and Winthrop—and parasitization ran comparatively low, 13 to 27 per cent. Possibly some unknown climatic factor affected fertilization of the eggs that year. It seems probable that the natural mortality occurring in 1939 and 1940 represents the more normal field conditions.

Among the ***Cnidocampa*** prepupae that bore 1 or more ***Chaetexorista*** eggs, the percentages bearing 1, 2, 3, 4, 5, and more than 5 eggs were determined for each of the 65 collections. The regressions of the percentages bearing 1 egg, 2 eggs, etc., on percentages of parasitization were calculated in order to obtain an estimate of egg distribution at different levels of parasitization. Table II summarizes these data.

The data given in Table II indicate only slight variations in the proportion of larvae that bore 2 eggs between 25 and 85 per cent parasitization. They also indicate no more than slight variations in the proportion of larvae that bore 3, 4, or 5 eggs at the different levels of parasitization. There is thus a rather striking indication that eggs were deposited without discrimination as to whether or not a host larva already bore eggs. This was probably due in part to the more exposed position or the greater attractiveness of certain host larvae to the ovipositing parasites.

The data in Table II also indicate in a general way the proportion of eggs wasted by a duplication in egg deposition. Since the average number of eggs deposited increases with the percentage of parasitization, a correlation between the percentage of parasitization and the percentage of ineffective eggs is perhaps to be expected. When calculated for the 65 field collections, however, only a barely significant correlation ($r=0.30$) was found. Such a small correlation was without doubt due partly to the high incidence of natural mortality in the 1941 collections, for if data for 1941 are omitted the correlation between the two percentages is highly significant ($r=0.72$). Furthermore, the existence of an underlying correlation is clearly indicated if the prepupae from all collections that bore 1, 2, 3, 4, 5, and more than 5 eggs are tabulated separately, and the percentage of parasitization for each of these groups is determined. These percentages are, respectively, 62, 78, 87, 91, 93, and 97. Grouped in this manner the correlation coefficient for percentage of parasitization and percentage of ineffective eggs is high.

TABLE II

ESTIMATED PERCENTAGE OF PARASITIZED PREPUPAE OF *Cnidocampa flavescens* THAT BORE VARIOUS NUMBERS OF *Chaetexorista* EGGS AT DIFFERENT LEVELS OF PARASITIZATION IN 65 FIELD COLLECTIONS

Number of *Chaetexorista* Eggs Deposited per Host Prepupa	Errors of Estimate for Regression Lines	Percentage of Prepupae bearing *Chaetexorista* Eggs at Indicated Level of Parasitization						
		25%	30%	40%	50%	60%	75%	85%
1	13.4	56	53	47	41	35	26	20
2	7.7	27	26	25	24	23	21	20
3	8.4	12	13	14	15	16	17	18
4	3.6	4	5	6	7	9	11	12
5	2.5	1	2	3	4	5	6	7
5+	11.3	0	1	5	9	12	19	23

Summarizing all collections, there were 4,137 effectively parasitized host prepupae, which bore 11,908 eggs, or an average of 2.88 eggs per prepupa. Of the prepupae that bore eggs, 77 per cent were effectively parasitized; yet hibernating *Chaetexorista* that would have caused the death of the host developed from only 30 per cent of the eggs deposited.

Calculations regarding the number and distribution of eggs deposited on the prepupae in each collection provide data on the searching ability and discrimination of the adult female parasite. The expected distribution of eggs per host prepupa, had they been deposited as in a Poisson distribution, was worked out for each collection. From each of these distributions the expected percentage of larvae bearing eggs was computed and plotted against the mean number of eggs deposited on one host larva, as shown in figure 4, *A*. The dots represent the actual percentages. The log values of the actual percentages of larvae bearing no eggs for each collection were used in conjunction with the mean egg values in calculating the regression equation ($E=1.932753-0.2431x$).

Expected log values were transformed back to percentages and their complements were plotted (fig. 4, *B*). The error of estimate in terms of logarithms is 0.1025. The curve for the percentage of parasitization as plotted in figure 3 (fig. 4, *C*) has been included here to emphasize the discrepancy between egg deposition and effectual parasitization. Curves *A* and *B* show that as the number of *Chaetexorista* eggs deposited on the host larvae increases there is less chance that the deposition of an additional egg will increase the proportion of host larvae parasitized. A comparison of curves *A* and *B* shows that *Chaetexorista* eggs are not distributed as they would have been had each host larva an equal

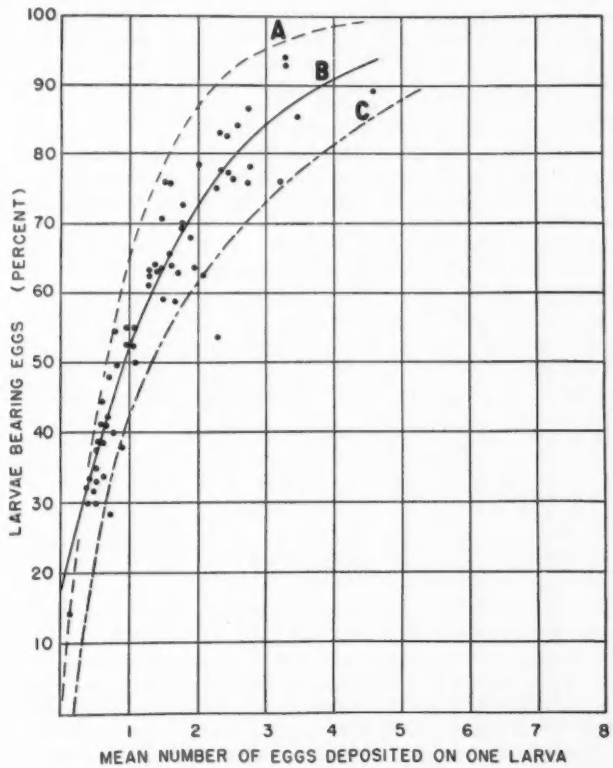

FIGURE 4. Correlation between the percentage of *Cnidocampa* larvae bearing eggs and the mean number of eggs deposited on host larvae in each collection: *A*, Curve showing percentage of larvae that would have borne eggs had they been deposited as in Poisson distribution; *B*, Curve fitted to percentage of larvae bearing eggs; *C*, Curve from figure 3 showing for comparison the correlation between the percentage of parasitization and the mean number of eggs deposited on the host larvae in each collection.

chance of being found and attacked, and therefore the percentage of host prepupae bearing eggs is smaller than it would have been had that been the case. The curves also show that there is an increase in the departure from random, or chance, distribution as the proportion of host prepupae bearing eggs increases from 30 to about 90 per cent of the prepupae in a collection.

A number of workers have studied the mathematical relation between entomophagous parasites and their hosts. In 1910 Fiske (8) worked out the probability of the occurrence of superparasitism, presenting a graph indicating the mathematical probability of an increase in percentage of parasitization with each additional egg deposited. In 1924 and 1929 Thompson (9) and (10) developed this conception further. He first showed that, if the eggs of a parasitic species are deposited at random, the expected parasitization may be expressed by the equation $y = N\left(1 - e^{\frac{x}{N}}\right)$, where N = total number of hosts, x = number of parasite eggs distributed, y = number of hosts parasitized, and $e = 2.71828$. Later he showed that when superparasitism occurs and only one parasite develops on a single host, if the reproductive rate of the parasite is greater than that of the host, superparasitism will not greatly retard the process of control in cases where control within a reasonable time would otherwise be probable.

Neither Fiske nor Thompson published any field data, but in 1933 Clausen, Jaynes, and Gardner (2), reporting on the parasitization of the Japanese beetle by the larvivorid fly *Centeter cinerea* Ald., used Fiske's curve and plotted counts of eggs deposited on beetles in 11 field collections containing from 200 to 1,000 beetles each. Their data show that *Centeter* eggs were distributed on fewer hosts than they would have been had each beetle had an equal chance of being attacked, and they conclude that this was because parasitized beetles are more sluggish than healthy ones. Studies by Beard (1) regarding parasitism of the squash bug (*Anasa tristis* DeG.) by the larvivorid *Trichopoda pennipes* F. indicate the same sort of a distribution of parasite eggs. Conclusions made in this study regarding egg deposition by *Chaetexorista* agree closely with those regarding egg deposition by *Centeter* and *Trichopoda*.

The results of all these studies emphasize the fact that the basis for observations regarding the dispersion of eggs by a female parasite must be the actual deposition of eggs, and not the number of hosts parasitized. They also emphasize that a comparison of an actual distribution with that in which each host has an equal chance of being attacked will not be satisfactory if the parasite has the ability to select unparasitized hosts for egg deposition. It is well known that some parasites have this ability to a considerable degree. Others, such as *Collyria calcitrator* Grav., studied by Walker (11), show a slight discriminatory power. Large groups of entomophagous parasites, however, do not appear to have this ability. The writer believes that the eggs of a parasite, that shows no ability to select unparasitized hosts for oviposition, will seldom be distributed among as many hosts as would be the case had each host an equal chance of being attacked. Probably the most important reason for this is the unequal exposure of the host population, although

undoubtedly the relation between actual and random distribution of eggs will vary greatly in different species.

EFFECT ON CNIDOCAMPA POPULATIONS OF PARASITIZATION BY CHAETEXORISTA

No quantitative data are available regarding *Cnidocampa* populations, either before or after the introduction of *Chaetexorista*. Certain generalizations are, nevertheless, of considerable interest. Since the larvae are easily killed by arsenical sprays, infestations on street trees are usually controlled. Those in back yards and on vacant lots, on the other hand, are likely to persist for a number of years.

The insect attracted little attention until about 1921, when considerable defoliation was observed throughout the Roxbury and Dorchester sections of Boston. Heavy infestations persisted throughout this area, spreading as far south as Quincy, until about 1929, when there was a noticeable decrease. Since then there has never been any appreciable feeding in that area. In 1923 some defoliation occurred north of Boston, at Winthrop, and, although only a few trees were involved, the number of defoliated areas increased rather steadily through 1932. At that time the insect was prevalent throughout Swampscott, Lynn, Nahant, Chelsea, Revere, Winthrop, Medford, and Cambridge. A marked decrease took place in 1933 and 1934, but in 1936 there was a decided increase which continued through 1938. Since that time light to medium infestations have persisted in small, isolated localities throughout much of the infested area north of Boston, notably in Cambridge, Chelsea, Revere, and Winthrop, and some severe defoliation has occurred in Salem and Beverly.

There is a temptation to ascribe the general decrease in *Cnidocampa* infestations north of Boston in 1933 and 1934 to the establishment of *Chaetexorista* in 1930, and the increase in infestations from 1936 through 1938 to the heavy parasite mortality during the winters of 1933 and 1934. In the opinion of the writer, *Chaetexorista* probably has played an important role in these fluctuations, but certain facts indicate that the parasite is by no means entirely responsible. In the first place, two areas in the southern part of Boston (Roxbury and Dorchester) that were kept under observation from 1922 to 1930 were defoliated every year until 1930, when there was a sharp decline. This was before the establishment of *Chaetexorista* could have affected the population of *Chidocampa*, and there has never been defoliation in these areas since that time. In the second place, heavy infestations in Swampscott and Nahant, which showed a sharp decline during 1933 and 1934, did not increase after 1936. Finally, severe defoliation occurred in Salem and Beverly for the first time after the cold winters of 1933 and 1934.

SUMMARY

The oriental moth (*Cnidocampa flavescens* (Walk.)), a native of eastern Asia, was discovered in this country at Dorchester, a part of Boston, Mass., in 1906. The area of infestation increased very slowly and in 1943 included only about 300 square miles in the environs of Boston. Oriental moth larvae feed on the foliage of a number of trees,

with Norway maple the preferred species, pear and cherry being among other trees attacked.

In 1929 and 1930 a larvivorid fly, *Chaetexorista javana* B. and B., parasitic on *Cnidocampa* in Asia, was shipped to this country from Japan. The parasite became established in this country almost immediately, and collections at the liberation points in 1933 indicated that it had parasitized more than 60 per cent of the oriental moth material collected. *Chaetexorista* overwinters as a second-instar larva within the hibernating prepupa of the host.

Temperatures between 0° and —5° F. kill a high proportion of the hibernating parasites, but temperatures at least as low as —24° do not affect the unparasitized host prepupae adversely. Parasitized host prepupae, however, are killed if the parasite dies. Minimum temperatures of —19° occurred in Boston in 1933, and the *Chaetexorista* population was reduced to a very low level. By 1942, however, it had increased to the point where 54 per cent of the prepupae collected at the liberation points were parasitized, but minimum temperatures of —14° that winter again severely reduced the parasite population. Considerable mortality of hibernating *Chaetexorista* larvae also occurred during winters when the official minimum temperature at Boston was several degrees above zero.

A comparison of the percentages of parasitization at 9 collection points over an 11-year period indicates that *Chaetexorista* is parasitizing about the same proportion of its host population throughout the whole area sampled.

There is a highly significant correlation between the mean number of *Chaetexorista* eggs deposited and the percentage of parasitization that may be shown by curvilinear regression. The female parasite deposits eggs on fewer host larvae than if the eggs were distributed at random, and as the percentage of parasitization increases from 30 to about 90 the departure from a random distribution increases. Only one *Chaetexorista* develops in a host. A large proportion of the eggs deposited are therefore ineffective, because they are laid on host larvae already bearing eggs. About 77 per cent of the larvae found bearing eggs were parasitized, but only 30 per cent of the eggs laid resulted in the death of a host.

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INSETOS DO BRASIL, Vol. V, Lepidopteros, Part 1, by A. da Costa Lima. 379 pages, 235 text figures. Escola Nacional de Agronomia, Serie Didatica No. 7, 1945.

The first part of this work covers the Jugate Lepidoptera and that part of the suborder Frenatae, division Heterocera, usually referred to as the Microlepidoptera. Since this is an inexact term, the superfamilies Incurvarioidea, Nepticuloidea, Cossoidea, Castnioidea, Zygaenoidea, Tineoidea, Tortricoidea and Pterophoroidea are covered.

The first 146 pages are about equally divided between an excellent discussion of the structure, metamorphosis and bionomics of the order and an extensive bibliography. The systematic portion includes a characterization of superfamilies and families but only occasional examples of included species, a necessary limitation for a work of its size. Under each category an artificial key to the included groups is supplied, down to the separation of families. Brief bibliographies are included.

The format is excellent and the printing and paper are good. Line cuts surpass the half-tones in quality, but most of the latter are good.

As a guide to an initial acquaintance with the classification of the microlepidoptera down to families the book appears to be thorough and excellent. Barring the fact that it is in Portuguese, it would be of wide value. The reviewer finds himself envying young lepidopterists of Brazil a clear approach which he lacked in his own early excursions in this field.—A. W. L.

MONOGRAPH OF THE FAMILY MORDELLIDAE (COLEOPTERA) OF NORTH AMERICA, NORTH OF MEXICO, by Emil Liljeblad. Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 62, 229 pages, VII plates. Ann Arbor, 1945. Price, $2.00.

To those who have known the quiet courtesy of Mr. Liljeblad through his many years of association with the Field Museum this publication will seem a fitting monument to his long devotion to a difficult family of inconspicuous beetles. The fact that the group is difficult for the ordinary taxonomist should guarantee the value of a revision by such a conscientious student. Certainly his knowledge must be the last word on the classification of the family for the present. The introduction bears further tribute to the care with which the study has been pursued, and the footnote on page ten stating that the manuscript was completed in 1929 and that the substitution of the generic name *Pentaria* for *Anthobates* is the only addition since that date, shows that the results were far from hastily presented.

The *Monograph* is beautifully printed. The seven plates are made up of skillfully executed drawings of structural details and of entire insects and are nicely reproduced. This publication should be essential to all libraries on the beetles.—A. W. L.

A NEW EUPHALERUS AND NOTES ON OTHER SPECIES OF PSYLLIDAE FROM IDAHO

(Homoptera: Psyllidae)

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Honolulu, T. H.

This paper presents the description of a new species of *Euphalerus* and some notes on the distribution, host plants and biology of several other species of Psyllidae collected in Idaho. In addition, the rearing of three genera of parasites from hackberry psyllids is reported. The opportunity of making most of these collections was afforded by the United States Bureau of Entomology and Plant Quarantine during the writer's service in the Division of Fruit Insect Investigations.

Euphalerus idahoensis n. sp.

(Figures 1, 1a and 2)

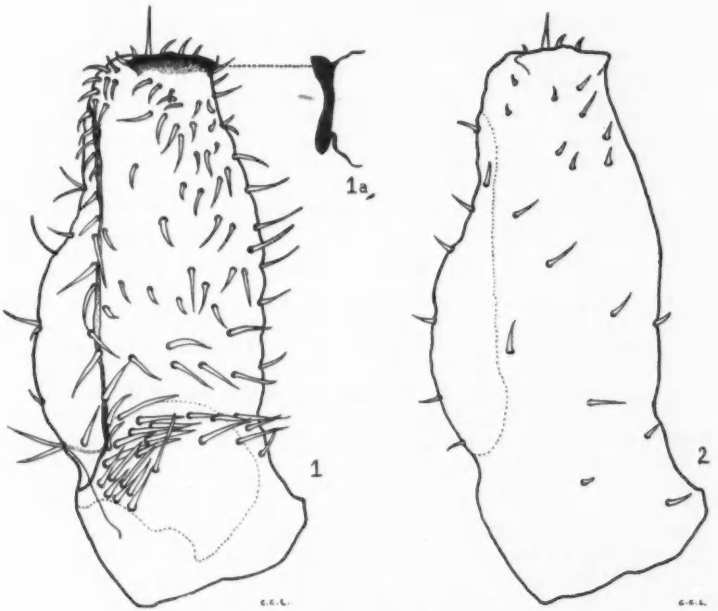
Color.—General color dark orange red with white and red vermiculations on vertex and thorax. Antennae black apically and on distal portion of other segments except basal three which are uniformly yellowish brown. Forewings subhyaline, amber colored. Abdomen of male pale orange to orange red; female abdomen usually greenish in life except for reddish genitalia.

Structure.—Length to tip of folded wings 3.5–4.0 mm. Length of body 3.1–3.7 mm. Length of forewing 2.7–3.0 mm. Width of head 0.90–0.96 mm. Length of antennae 1.5–1.7 mm. Length of vertex at median suture 0.28 mm. Width of thorax 0.9–1.0 mm. *Head* only slightly deflexed, produced almost horizontally in life (usually appearing strongly deflexed on dry specimens). Vertex flattened but bearing a distinct, though shallow, discal fovea on each side of median suture; beset with short, white capitate hairs. Genae produced on same plane as vertex, large, conical in form, equal in length to vertex, contiguous basally but divergent distally, tapering evenly to subacute apices, beset with conspicuous white pubescence. Antennae 1½ times as long as width of head.

Forewings rugose, about twice as long as broad, apical margin broadly rounded; pterostigma short but broad; marginal cells subequal in size, each bearing an inconspicuous alar radula extending in from margin; a third such radular area between the marginal cells. Posterior tibiae with three large black spurs on inside and one on outside of apex.

Genitalia.—Male: Proctiger 0.40 mm. long, appearing straight on dry specimens, but seen to curve sharply cephalad at base when entire structure is revealed by dissection or clearing; sides subparallel, straight to roundly truncate apex. Forceps 0.30 mm. long above ventral genital valve, 0.39 mm. long in entire length; maximum width 0.15 mm. in lateral view; outside lateral surface produced cephalad as a thin flange whose anterior margin forms a distinct convexity over region

from ventral genital valve to subapex; mesal face of flange distinctly ectad from that of thicker forcep proper; posterior margin practically straight from base to middle thence curved gently cephalad to base of apex; in dorsal view forceps curved gently mesad distally, terminating in a short, black, shallowly bifid tooth produced dorso-mesad from caudal two-thirds of mesal margin; in lateral view apices roundly truncate with apical tooth appearing as a black, blunt ridge. Outside face of forceps smooth except for a few small, scattered setae; inner face



Male forcep of *Euphalerus idahoensis* Jensen
Figure 1. Lateral view of inner face. Figure 1a. Dorsal view of apical tooth.
Figure 2. Lateral view of outer face.
(Drawings by Mrs. C. C. Low)

beset with large, acute setae arranged as follows: scattered or forming irregular rows over caudal half from apical tooth to ventral genital valve, a retrose group a little above base near anterior margin, another group on antero-mesal face of apex and a single row extending from antero-dorsal margin to ventral genital valve (thence curving cephalad) in a line closely paralleling posterior margin of forceps and forming a sharp line of demarcation between anterior flange and main body of forcep. In caudal view forceps strongly arched laterad in basal half with posterior margins convergent half way to apices. *Female:* Dorsal

genital valve 1.05 mm. long, over half as long as normally distended abdomen, tapering gradually to moderately acute apex; dorsal surface of apical half beset with many short, stout setae and a few long, slender hairs. Circum-anal ring elongate-ovate in outline, composed of a row of slit-like pores. Ventral valve shorter and more acute than dorsal; a group of slender hairs on ventral surface near base; elongate hairs and short setae sparse over distal half.

Holotype male, ***Allotype*** female and numerous ***paratypes*** collected at Pollock (Idaho County), Idaho (elevation 2300 ft.) July 19, 1943 on *Cercocarpus ledifolius* Nutt. (mountain mahogany) by D. D. Jensen. Six male and fifteen female paratypes collected on the same host at the same locality September 25, 1942 (Jensen). Holotype, allotype and paratypes will be deposited in the United States National Museum and paratypes in the collections of the California Academy of Sciences, J. S. Caldwell, L. D. Tuthill and the writer.

This species is closely related to ***Euphalerus adustus*** Tuthill but is readily distinguished by the difference in form of the male forceps. It is also somewhat larger and darker in color than ***adustus***.

Adults only were taken. They were found on both the leaves and stems of mountain mahogany. The specimens collected September 25, 1942 were found in association with nymphs and adults of *Psylla difficilis* Tuthill.

MISCELLANEOUS PSYLLID RECORDS FROM IDAHO

Below are given some Idaho locality and host records for several species of Psyllidae with parasite records for hackberry psyllids. All collections were made by the writer except where otherwise indicated.

Psylla difficilis Tuthill: All collections were made from *Cercocarpus ledifolius* (mountain mahogany). Numerous adults and nymphs, Pollock (Idaho County), October 16, 1941, and September 25, 1942. (The specimens collected on the latter date were in association with ***Euphalerus idahoensis*** Jensen.) Adults only, Pollock and Whitewater (Idaho County), July 19, 1943. Adults and nymphs, Lucile (Idaho County), September 25, 1942. The nymphs of ***difficilis*** are naked and feed on the under surface of the leaves.

Psylla ribesiae (Crawford): Adults from wild currant (***Ribes*** sp.), Arimo (Bannock County), May 29, 1937 (D. Farr and D. D. Jensen). Three adults and many nymphs collected on wild currant, Malta (Cassia County), July 10, 1943. Adults and nymphs of this species have been taken frequently by the writer in other western states. Although adults have been found on other plants, the nymphs have always been taken only on wild currant by the writer. They are naked and do not form waxy cells. Klyver (1932) reported having collected numerous nymphs and adults of this species from *Ceanothus thyrsiflorus*, at Stanford University, California. He stated that the nymphs produced waxy cells on the under side of the leaves. Two of Klyver's psyllid slides, labelled ***ribesiae***, in the Stanford University collection were examined by the writer through the kindness of Professor G. F. Ferris. The slides carried a key number but not the host or locality data. Although labelled ***ribesiae***, the adults on the slides are

unquestionably in the genus *Euphalerus*. One slide is of *E. vermiculosus* Crawford; the other is of *E. jugovenosus* Tut. *Ceanothus* is the true host for these species of *Euphalerus*, and the nymphs, at least of *jugovenosus*, form waxy cells on the under side of the leaves as described by Klyver (1932) for "*ribesiae*." In view of the above facts, it is the writer's opinion that the nymphs taken from *Ceanothus thyrsiflorus* by Klyver were not nymphs of *Psylla ribesiae*, but of a species of *Euphalerus*. Furthermore it is probable that *ribesiae* breeds only on *Ribes* species. This conclusion receives additional support from the fact that practically all published records for this species list *Ribes* as the host plant. Although these records refer almost exclusively to adults only, Tuthill (1943) reported examining several adults, accompanied by nymphs, which were collected on *Ribes* sp.

Psylla coryli Patch: Adults only collected from *Purshia tridentata* as follows: Bliss (Gooding County), October 5, 1941; Emmett (Gem County), October 8, 1941; Mann's Creek near Weiser (Adams County), October 12, 1941.

Psylla alba Crawford: One adult male from *Cercocarpus ledifolius*, Pollock (Idaho County), October 16, 1941. The presence of *alba* on this plant does not imply true host relationship as this species breeds on willow.

Arytaina pubescens Crawford: Adults only from *Purshia tridentata* as follows: Bliss (Gooding County), October 5, 1941; Mann's Creek near Weiser (Adams County), October 12, 1941; Midvale (Washington County), September 24, 1942.

Pachypsylla venusta (Osten Sacken): Numerous adults and nymphs of this well known species were collected from hackberry (*Celtis* sp.). Lucile (Idaho County), October 16, 1941. During February, 1942, four months after the leaf petiole galls had been collected, adults were still issuing from the galls held at room temperature.

Pachypsylla celtidis-mamma (Fletcher): Six adults collected on *Purshia tridentata*, Bliss (Gooding County), October 5, 1941. Adults and nymphs from hackberry (*Celtis* sp.), Lucile (Idaho County), October 16, 1941. The nymphs occurred in flattened leaf galls on the same trees which bore the galls of *Pachypsylla venusta* (O. S.).

Pachypsylla parasites: Hackberry foliage, carrying galls of *Pachypsylla venusta* and of *P. celtidis-mamma* was collected at Lucile, October 16, 1941, and left in a cage for several months. Between February and May, 1942, fourteen adult parasites emerged. These were identified by Mr. A. B. Gahan of the United States National Museum as *Eurytoma* sp., *Callimome* sp. and *Psyllaephagus* sp. near *pachypsyllae* (How.). Examination of the psyllid galls revealed that both species had been parasitized. However, it could not be determined definitely from which psyllid species the respective parasites had emerged.

LITERATURE CITED

Klyver, F. D. 1932. Biological notes and new records of North American Chermidae (Homoptera). Ent. News 43: 39–40.

Tuthill, L. D. 1943. The psyllids of America North of Mexico (Psyllidae: Homoptera). Iowa State College Jour. Sci. 17: 488.

A NEW SPECIES OF DIRHAGUS WITH NOTES ON OTHER EUCNEMIDAE

(Coleoptera)

JOSEF N. KNULL,
The Ohio State University[1]

Dirhagus wrighti n. sp.

Male.—Slender, elongate, subcylindrical; dark brown, clothed with short recumbent brown pubescence.

Head convex; clypeal margin sinuately rounded in front, margin greater than width between antennae; surface finely punctured; antennae when laid along side, extending to apical third of elytra, tapering in width toward outer joints, scape stout, second joint about as long as broad, third joint as long as scape, fourth to tenth joints inclusive of equal length, shorter than third, eleventh longer than third, third to tenth inclusive serrate.

Pronotum wider than long, wider than base of elytra; sides subparallel on basal half, broadly rounded anteriorly; anterior margin broadly rounded; posterior margin sinuate, hind angles prolonged; disk convex in front, depressed basally, small median depression and small round lateral depression each side at middle, sinuate lateral carina extending nearly to anterior margin, carina on hind angle extending to middle, anterior supplementary carina extending along front margin and down each side, then running diagonally, not reaching middle; surface finely, densely punctate. Scutellum elongate, truncate in front, rounded posteriorly.

Elytra elongate; sides subparallel, broadly rounded to suture at apices; disk convex; surface indistinctly striate, interspaces densely, minutely punctate.

Beneath, juxta-sutural sulcus deep, narrow, outer carina well marked. Metathoracic episterna broad, sides parallel. Posterior coxal plate dilated internally, sides parallel externally. Fourth tarsal segment lobed.

Length 6 mm.; width 2 mm.

Described from a specimen in author's collection, collected in light trap at New Smyrna, Fla., June 2, by Dr. Mike Wright and named for him.

This species runs to *D. impressicollis* (Bonv.) in Horn's key.[2] It can be separated, however, by the smaller median depression and the finer punctures on the pronotum.

I am indebted to Mr. W. S. Fisher, who kindly compared the specimen with West Indian species in the National Museum collection.

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[1]Contribution from Department of Zoology and Entomology.

[2]G. H. Horn, 1886, Trans. Amer. Ent. Soc., 13 : 5–58.

Isorhipis obliqua (Say)

Eucnemis obliqua Say, 1839, Trans. Amer. Philos. Soc., 6 : 187.
Tharops obliquus LeConte, 1853, Trans. Amer. Philos. Soc., (2) 10: 412.
Tharops obliqua Bonvouloir, 1870, Ann. Soc. Ent. Fr., 105, pl. 5, fig. 1; Horn, 1886, Trans. Amer. Ent. Soc., 8 : 8; Van Horn, 1909, Proc. Wash. Ent. Soc., 11 : 54–61; Blatchley, 1910, Ind. Dept. Geol. & N. R., Bul. 1, 703.
Isorhipis ruficornis (Say) and *I. obliqua* (Say) of authors.

This species has been confused in the literature with *I. ruficornis* (Say). Both Bonvoulior and LeConte recognized the true *obliqua*. Van Horn figured *obliqua*. Blatchley figured *ruficornis*.

Large numbers of *I. obliqua* were reared from sugar maple, American beech and ironwood branches collected in Delaware Co., Ohio. Adults feign death and when disturbed are capable of springing at least an inch into the air. Numbers of the interesting parasite *Vanhornia eucnemidorum* Crawf. were reared from the infested sugar maple.

The beetles vary in length from 4.3 to 8.3 mm. Color varies from black with brown legs, antennae and an elongate area back of scutellum to black, with brown legs, antennae and elytra. Pygidium of both sexes has a strong median carina.

Isorhipis ruficornis (Say)

Melasis ruficornis Say, 1823, Jour. Acad. Nat. Sci. Phila., 3 : 166.
Eucnemis ruficornis (Say), 1836, Trans. Amer. Philos. Soc., 6 : 186.
Tharops ruficornis LeConte, 1853, Trans. Amer. Philos. Soc. (2) 10 : 411; Bonvouloir, 1870, Ann. Soc. Ent. Fr., 106, pl. 5, fig. 2.

Through the kindness of Dr. A. B. Champlain I have been able to examine specimens of *I. ruficornis* which I had reared years ago from infested black birch sticks collected at Mechanicsburg, Pa. They are black, with basal half of elytra, antennae and legs brown. The black apical area of elytra varies in size and LeConte records one with entire elytra brown. Pygidium of both sexes contains but a faint indication of carina and sculpture of elytral interspaces is much finer.

Dirhagus imperfectus (Lec.)

Specimens were reared from moist, decayed American beech log collected in Hocking Co., Ohio, by D. J. & J. N. Knull.

Hylochares nigricornis (Say)

Reared from decayed willow snag 8 inches in diameter collected in Hocking Co., Ohio, by D. J. & J. N. Knull. Most of the pupal cells were constructed in the sound wood near the base where moisture was more abundant. Adults vary in length from 3.3 to 9.5 mm.

Hylis terminalis (Lec.)

Reared from moist, decayed American beech log collected in Hocking Co., Ohio, by D. J. & J. N. Knull.

A REVIEW OF THE SPECIES OF BITING MIDGES OR CULICOIDES FROM THE CARIBBEAN REGION
(Diptera: Ceratopogonidae)[1]

IRVING FOX
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In the Caribbean region one soon becomes painfully familiar with the biting midges (or sand flies) that abound in the area. Although they are vicious bloodsucking pests and even transmitters of disease, little attention has been devoted to them by entomologists. But few species have been described and hardly anything has been done which would contribute to knowledge of their life history and control. This paper is an attempt to provide some of the fundamental taxonomic data which should precede any work on biology and control. In it new species are described, a key is given to the females of the known species, and their grographical distribution annotated. The paper is based upon the collections of the Department of Medical Zoology, School of Tropical Medicine at San Juan, Puerto Rico, which accumulated there largely through the efforts of the late Doctor William A. Hoffman.

Inadequate material has made it necessary to limit this consideration to the females. To be sure, in the final analysis, the taxonomy of the group cannot be complete until the terminalia of the males have been subjected to an exhaustive study. The males, however, infrequently come to hand; and a classification of the species based upon characters of the much more common females is a decided necessity. So far, the taxonomic characters of the female seem to be quite adequate to separate the species, and in some cases even better than the male terminalia. For example, Root and Hoffman (1937) in their consideration of the terminalia of *Culicoides furens* (Poey) state, "It should be noted, however, that it is only in greatly compressed mounts that the true form of the tip of the aedeagus, the apicolateral processes and especially of the harpes, can be seen. In mounts made without pressure the harpes may appear of an entirely different form."

In preparing specimens for study the writer attempts to secure both pinned and slide-mounted examples of each species, the former to be studied under a dissecting microscope, the latter under a compound microscope. From the pointed and pinned specimen the general size and coloration and the very important mesonotal pattern are ascertained; from the specimens mounted on slides the other details are worked out. In mounting specimens on slides the writer uses the beechwood creosote method reported by him in 1942—the specimens, if dried or previously preserved in alcohol, are simply allowed to remain in the crosote for 24 hours and thereafter mounted in balsam. It is

[1]Contribution from the School of Tropical Medicine, San Juan, Puerto Rico, and the 326th Station Hospital, APO 853, care of P.M., Miami, Fla. Thanks are due to Dr. Jose Oliver Gonzalez of the Department of Medical Zoology, School of Tropical Medicine and Major Joseph E. Rechany, M. C., AUS., for providing facilities to accomplish the work.

advisable to separate the head, thorax, abdomen and wings before applying the cover slip to the slide; this facilitates study of these structures. Where a species is represented by a single specimen, notes should be made upon the coloration and the specimen mounted on a slide.

The lack of material has necessitated the exclusion of Mexico from this treatment. The writer has seen examples of all the species treated except ***debilipalpis*** Lutz. From the area 18 species are now known. This number probably represents a small part of the total occurring in the region, and even casual collections made in the future may be expected to yield new species. Where a group bids fair to be abundant in species, as this one does, it is inadvisable to synonymize species whose type localities are widely separated, particularly if the evidence for the synonymy is to be found in only one sex. In his excellent paper of 1937, De Costa Lima synonymizes ***diabolicus*** Hoffman from Mexico with ***guttatus*** (Coquillet) from Brazil, and casts doubt on the validity of ***trinidadensis*** Hoffman from Trinidad, which he indicates may be a synonym of ***insignis*** Lutz from Brazil, all on the basis of examinations of the females of these species. The writer is inclined to reserve his opinion on these matters until more is known of the taxonomic characters and the distribution of the species. By the same token, hesitancy is desirable in reporting species from places very far removed from their type localities, as for instance, ***baueri*** Hoffman described from Maryland and reported from Mexico by Root and Hoffman (1937, p. 163)

The larvae and pupae of ***furens*** (Poey) and ***phlebotomus*** (Will.) have been described by Painter (1928) and the pupae of ***borinqueni***, ***arubae***, and ***heliconae*** Fox and Hoffman by the writer (1942). Otherwise little is known of the habitats of the immature stages, or their structure, for the remainder of the species. In the writer's paper of 1942 references are given to several important articles by European authors which treat of the immature stages of the group. Attention is invited to the outstanding papers of Dove, Hall, Hull, Platts, Prince, and Shields, published during the years 1932 to 1943, which deal with the economic importance and control of *Culicoides* in the United States (see Bibliography).

KEY TO THE FEMALES OF THE CARIBBEAN SPECIES OF CULICOIDES (EXCLUSIVE OF MEXICO)[2]

1. Second radial cell mainly included in a dark spot or stigma.....2
   Second radial cell mainly included in a light spot.....11
2. Stigma extending well beyond second radial cell so that more than half of first radial cell is in a dark spot.....3
   Stigma not extending well beyond second radial cell so that more than half of first radial cell is in a light spot.....6
3. Anal cell with many macrotrichia; mesonotal pattern consisting of three longitudinal dark lines.....**trilineatus**
   Anal cell with few or no macrotrichia; mesonotal pattern not as above.....4

[2]Johannsen (1943, p. 779) indicates that *Ceratopogon decor* Williston (1896, p. 281) is of doubtful generic position and may be a *Culicoides*. The writer is not of the opinion that this is a *Culicoides*, hence it is excluded from the key. Another species not included in the key is *fluviatilis* Lutz reported from Panama by Dunn (1934, p. 178) and Fairchild (1943, p. 572) as a *Culicoides*; it is, however, a species of *Serromyia*, and not a *Culicoides*.

4. Vein M_2 obliterated, replaced by a series of horizontally direct macrotrichia; anal cell with one white spot distally.....5
   Vein M_2 not obliterated, without macrotrichia; anal cell with two white spots distally one above the other.....**castillae**
5. Mesonotal pattern distinct; legs conspicuously banded.....**hoffmani**
   Mesonotal pattern not distinct; bands of the legs inconspicuous....**borinqueni**
6. Vein M_2 bisecting a distinct white spot basally.....7
   Vein M_2 passing below one to three spots, not bisecting a white spot basally..8
7. Legs uniform in color; mesonotum conspicuously bluish gray in appearance, **phlebotomus**
   Legs banded, femora with subapical and tibae with subbasal lighter annulations; mesonotum brown.....**loughnani**
8. Distal portion of cell R_5 with three round white spots arranged in a triangle; mesonotal pattern not consisting of dark brown punctations.....**stubalensis**
   Distal portion of cell R_5 without three round white spots arranged in a triangle; mesonotal pattern consisting of dark brown punctations.....9
9. Middle third of cell R_5 with a prominent dark spot in the form of the numeral "2".....**arubae**
   Middle third of cell R_5 not as above, with a dark spot more or less in the form of an inverted letter "Y".....10
10. Cell M_1 with three light spots.....**paraensis**
    Cell M_1 with two light spots.....**furens**
11. Vein M_2 not bisecting a light spot basally.....12
    Vein M_2 bisecting a light spot basally.....13
12. Mesonotum with dark brown punctations.....**oliveri**
    Mesonotum not as above.....**debilipalpis**
13. Mesonotum with a distinct pattern.....14
    Mesonotum without a distinct pattern.....16
14. Size large, about 2.00 mm.....**heliconiae**
    Size moderate, about 1.5 mm.....15
15. Distal portion of vein R_{4+5} obliterated, second radial cell not completely outlined.....**pseudodiabolicus**
    Distal portion of vein R_{4+5} not obliterated, second radial cell with outline complete and distinct.....**diabolicus**
16. Distal portion of vein R_{4+5} obliterated; first radial cell parallel to the costa...17
    Distal portion of vein R_{4+5} not obliterated; radial cells diagonal to the costa, **trinidadensis**
17. Tibiae with subbasal lighter annulations; posterior portion of radius present in middle area.....**inamollae**
    Tibiae uniform in color; posterior portion of radius obliterated in middle area.....**painteri**

Culicoides trilineatus n. sp.

Diagnosis: A moderate sized species, the female of which is about 1.5 mm. long, dark brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It is distinguished from other species particularly by the mesonotal pattern which consists of three dark longitudinal lines and by having the wings densely provided with macrotrichia.

Description: Female. Head dark brown to black. Eyes narrowly separated. Antennae not suitable for study. Third palpal segment large, swollen beyond the middle with a large circular sensory pit. Second segment slightly shorter than the third; fourth and fifth segments subequal.

Mesonotum grayish brown, anteriorly with three dark brown longitudinal lines which converge in the middle area, the outside ones continuing posteriorly and outlining a grayish area which includes a pair of large dark spots in the prescutellar depression. Scutellum brown. For further details of the mesonotal pattern see fig. 5. Legs dark brown,

banded, but not conspicuously so; tibiae at least with subbasal lighter annulations and some of the femora with subapical ones. Abdomen dark brown; spermathecae not suitable for study.

Wing (fig. 11) about 1.00 mm. long and .40 mm. wide, abundantly provided with macrotrichia over most of the wing surface including the anal cell. Cell R_5 with two light spots. Cell M_1 with one or two light spots; vein M_2 indistinct, replaced by horizontally directed macrotrichia. Cell Cu_1 and anal cell with one light spot each. Second radial cell located in a dark spot (stigma) which extends posteriorly so as to include most of the first radial cell. Radio-median cross vein inconspicuous, located in a white spot. Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Red Hook, St. Thomas, September 11, 1937, biting in the afternoon.

Culicoides castillae n. sp.

Diagnosis: A small species, the female of which is about 1.00 mm. long, dark brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It superficially resembles *hoffmani* new species from which it differs among other ways in having two white spots in the distal portion of the anal cell and in the character of the mesonotal pattern.

Description: Female. Head dark brown. Eyes very narrowly separated. Antennae not suitable for study. Third palpal segment enlarged but not markedly swollen beyond the middle with a large circular sensory pit. Second palpal segment about as long as the third; fourth segment longer than the fifth.

Mesonotum with two broad longitudinal dark bands enclosing a grayish area which posteriorly includes two large dark brown to black spots. Anteriorly the broad bands converge forming a dark area which extends laterally on each side in the form of transverse bands. Scutellum dark brown medially, grayish at the sides. For further details of the mesonotal pattern see fig. 3. Legs dark brown, banded, tibiae with subbasal lighter annulations and femora with subapical ones. Abdomen brown; spermathecae apparently single, but the specimen is not suitable for accurate study of this structure.

Wing (fig. 2) about .94 mm. long and .40 mm. wide with few macrotrichia which are limited to cells R_5 and M_1. Cell R_5 with four light spots. Cell M_1 with two light spots. Cell M_2 and Cell Cu_1 with one light spot each. Anal cell with three white spots. Second radial cell included in a dark spot which extends posteriorly to include most of the first radial cell. Radio-median cross vein inconspicuous, located in a light spot. Subcosta obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Puerta Castilla, Honduras, May, 1926, collected by R. H. Painter.

Culicoides hoffmani n. sp.

Diagnosis: A small species, the female of which is about 1.00 mm. long, brown in color with a distinctive mesonotal pattern, conspic-

uously banded legs, and definite wing markings. The mesonotal pattern is similar to *castillae* new species, but the markings and structure of the wing are very different.

Description: Female. Head dark brown. Eyes narrowly separated. Antennae not suitable for study. Third palpal segment markedly swollen at the middle bearing a large circular sensory pit. Third segment longer than the second.

Mesonotum with two triangular brown markings between which is a grayish area, which broadens posteriorly and includes two prominent dark spots in the prescutellar depression. Scutellum dark in the medial area, light at the sides. For further details of the mesonotal pattern see fig. 6. Legs dark brown, conspicuously banded; femora I and II with subapical lighter annulations, femora III uniform dark brown; all the tibiae with subbasal annulations and tibiae III with subapical ones as well. Abdomen dark brown; spermathecae double, subpsherical, one slightly larger than the other.

Wing (fig. 9) about .80 mm. long and .34 mm. wide, provided with macrotrichia in the apical region. Cell R_5 with three light spots. Cell M_1 with two light spots. Vein M_2 obliterated, replaced by horizontally directed macrotrichia. Cells M_2 and Cu_1 with one light spot each. Second radial cell included in a dark spot which extends posteriorly to include most of the first radial cell. Radio-median cross vein indistinct, located in a light spot. Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Camuto Village, Trinidad, April 11, 1941, biting, the types selected from a small series.

Culicoides borinqueni Fox & Hoffman

Culicoides borinqueni Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 110, 1944.

Distribution: Known only from Puerto Rico. A further record from Puerto Rico is Luquillo, May 12, 1932, female from a tree hole.

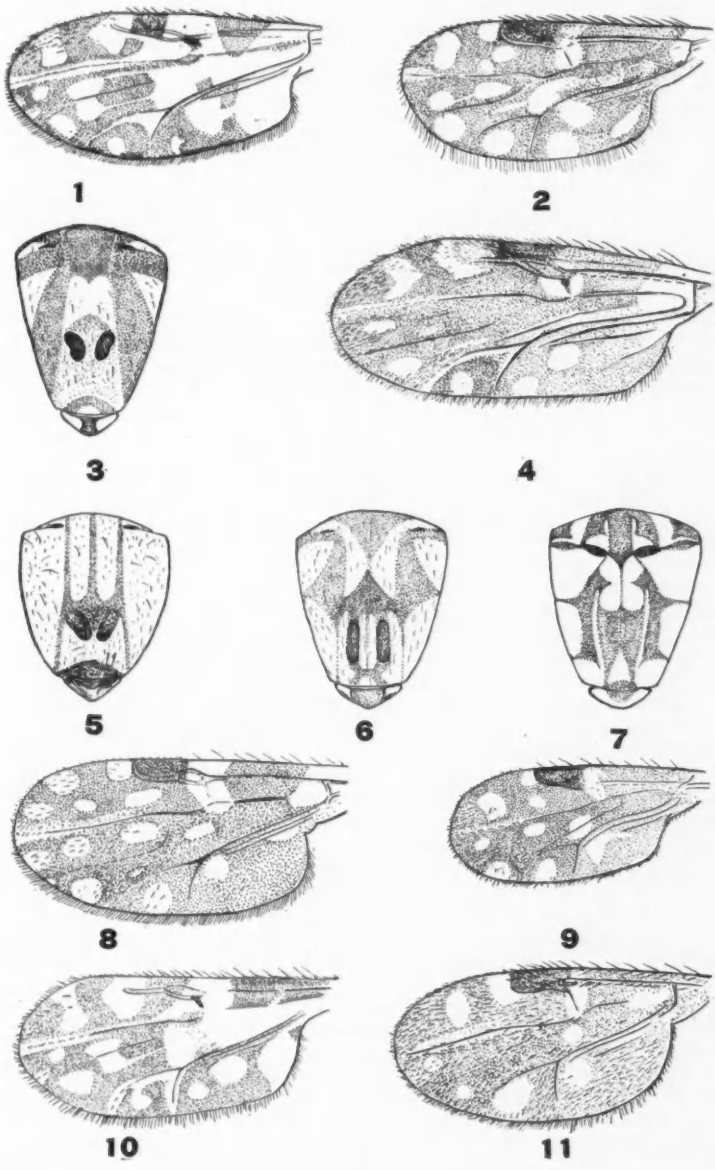
Culicoides phlebotomus (Williston)

Ceratopogon phlebotomus Williston, Ent. Soc. London, Trans., p. 281, 1896.
Culicoides phlebotomus Hoffman, Amer. Jour. Hyg., Vol. V, p. 285, 1925.
Culicoides phlebotomus Painter, Ann. Rpts. United Fruit Co. Med. Dept., p. 258, 1926.
Culicoides phlebotomus Root & Hoffman, Amer. Jour. Hyg., Vol. XXV, p. 151, 1937.
Culicoides phlebotomus Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. II, p. 414, 1937.

EXPLANATION OF PLATE I

(All drawings pertain to the female sex)

Fig. 1. *C. pseudodiabolicus* n. sp., wing. Fig. 2. *C. castillae* n. sp., wing. Fig. 3. *C. castillae* n. sp., mesonotal pattern. Fig. 4. *C. oliveri* Fox & Hoffm., wing. Fig. 5. *C. trilineatus* n. sp., mesonotal pattern. Fig. 6. *C. hoffmani* n. sp., mesonotal pattern. Fig. 7. *C. stubalensis* n. sp., mesonotal pattern. Fig. 8. *C. stubalensis* n. sp., wing. Fig. 9. *C. hoffmani* n. sp., wing. Fig. 10. *C. painteri* n. sp., wing. Fig. 11. *C. trilineatus* n. sp., wing.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Distribution: Known from the West Indies and Honduras. A further record is St. Croix, Cotton Valley, Sept. 8, 1937, a small series of females collected by Hoffman and Beatty.

Culicoides loughnani Edwards

Culicoides loughnani Edwards, Bul. Ent. Res., Vol. XIII, p. 165, 1922.
Culicoides loughnani Hoffman, Amer. Jour. Hyg., Vol. V, p. 282, 1925.
Culicoides loughnani Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 413, 1937.

Distribution: Known only from Jamaica. A further record from Jamaica is, female, Dec., 1933, collected by Dr. Kumm (no further data).

Remarks: Along with the original description of this species Edwards described a variety—*Culicoides loughnani var. jamaicensis*—from the same locality, Kingston, Jamaica. In the absence of adequate material from Jamaica, the writer is not able to determine the status of this name. It may represent a true variety, which is doubtful since it occurs in the same type locality, or it may be a distinct species. The possibility that it is a synonym of *C. l. loughnani* should not be dismissed.

Culicoides stubalensis n. sp.

Diagnosis: A moderate sized species, about 1.5 mm. long, brown in color with a distinctive mesonotal pattern, banded legs, and definite wing markings. It differs from other species in having three round light spots arranged in a triangle in the distal portion of cell R_5 of the wing.

Description: Female. Head brown. Eyes narrowly separated. Antennae with the last five segments longer than the first eight. Third palpal segment large, swollen beyond the middle with a large circular sensory pit. Second palpal segment shorter than the third, fourth and fifth segments subequal.

Mesonotum with two broad longitudinal brown bands enclosing a gray area anteriorly and a brown area posteriorly. Laterally there are gray bands interrupted by strands from the brown ones. Scutellum brown medially, gray at the sides. For further details of the mesonotal pattern see fig. 7. Legs brown, banded, femora with subbasal and subapical light annulations, tibiae at least with subbasal annulations, some of them with subapical ones as well. Abdomen dark brown; spermathecae double, subspherical, one much larger than the other.

Wing (fig. 8) about 1.10 mm. long and .44 mm. wide, abundantly provided with macrotrichia in the distal half. Cell R_5 with five light spots, the three distal ones arranged in a triangle. Cell M_1 with three light spots, vein M_2 passing below them. Cell M_2 with one or two light spots. Cell Cu_1 with one light spot. Anal cell with two light spots. Radio-median cross vein and most of the first radial cell indistinct, located in a light spot. Second radial cell located in a dark spot (stigma). Subcosta and posterior portion of the radius obliterated.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Stubal's Bay, Trinidad, July 4, 1941, collected from a light trap. The types were selected from a series of specimens.

Culicoides arubae Fox & Hoffman

Culicoides arubae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 109, 1944.

Distribution: Known only from Aruba, Dutch West Indies.

Culicoides paraensis (Goeldi)

Haematomyidium paraense Goeldi, Mus. Goeldi Mem. Vol. IV, p. 137, 1905.
Culicoides paraensis Lutz, Inst. Oswaldo Cruz Mem., Vol. V, p. 55, 1913.
Culicoides paraensis Dunn, Psyche, Vol. XLI, p. 178, 1934.
Culicoides paraensis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 414, 1937.
Culicoides paraensis Lutz and Nunez Tovar, in Carbonell's, La Parasitologia en Venezuela, Caracas, p. 258, 1938.
Culicoides paraensis Martorell, Puerto Rico Univ. Jour. Agr., Vol. XXIII, p. 210, 1939.
Culicoides paraensis Fairchild, Amer. Jour. Trop. Med., Vol. XXIII, p. 572, 1943.

Distribution: Described from Brazil and reported from Panama by Dunn and Fairchild, and from Venezuela by Lutz and Nunez Tovar and Martorell. Martorell states, "Of great economic importance, the only representative of this family in the region. This troublesome fly becomes a nuisance during the rainy season, attacking people with great aggressiveness and voracity. It is very abundant and initiates its attacks during the first hours of the morning as well as at dusk. Its common name among the people of the Valley is 'jejen'."

Culicoides furens (Poey)

Oecacta furens Poey, Mem. sobre la Hist. de la Isla Cuba, Vol. I, p. 237, 1853.
Ceratopogon maculithorax Williston, Ent. Soc. London, Trans., p. 277, 1896.
Culicoides maculithorax Lutz, Inst. Oswaldo Cruz Mem., Vol. V, p. 53, 1913.
Culicoides furens Hoffman, Amer. Jour. Hyg., Vol. V, p. 287, 1925.
Culicoides furens Painter, Ann. Rpts. United Fruit Co. Med. Dept., p. 255, 1926.
Culicoides furens Root & Hoffman, Amer. Jour. Hyg., Vol. XXV, p. 162, 1937.
Culicoides furens Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 414, 1937.
Culicoides furens Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 10, 1937.

Distribution: "This species is very widely distributed in tropical America, from the West Indies and Mexican coast to Brazil" (Root & Hoffman). It has been reported from Cuba, Puerto Rico, Jamaica, St. Vincent, Bahamas, Trinidad, Brazil, Mexico, Panama, Honduras, and Florida, Louisiana and Texas. Further records are: St. John, Cruz Bay, Sept. 9, 1937, three females; Santo Domingo, San Lorenzo, May 14, 1941, female, biting, collected by Dr. Mazzotti; Trinidad, Stubal's Bay, July 4, 1941, a series of females from a light trap.

Culicoides oliveri Fox & Hoffman

Culicoides oliveri Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 108, 1944.

Distribution: Known only from Haiti.

Remarks: The female wing of this species is illustrated in fig. 4.

Culicoides debilipalpis Lutz

Culicoides debilipalpis Lutz. Inst. Oswaldo Cruz Mem., Vol. V, p. 60, 1913.
Culicoides debilipalpis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.
Culicoides debilipalpis Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 7, 1937.

Distribution: Described from Brazil and reported from Trinidad by Macfie.

Culicoides heliconiae Fox & Hoffman

Culicoides heliconiae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 108, 1944.

Distribution: Known only from Venezuela.

Culicoides pseduodiabolicus n. sp.

Diagnosis: A moderate sized species, the female of which is about 1.5 mm. long, brown in color, with a distinctive mesonotal pattern, banded legs, and definite wing markings. It resembles *diabolicus* Hoffman from which it differs in having a mesonotum with a pair of large prominent dark spots in the prescutellar depression rather than small ones and in having the distal portion of vein R_{4+5} obliterated rather than as in that species.

Description: Female. Head dark brown to black. Eyes contiguous. Antennae with the last five segments much longer than the first eight. Third palpal segment swollen at the middle, bearing a sensory pit, thereafter tapering distally. Second segment slightly shorter than the third; fifth segment shorter than the fourth.

Mesonotum with two longitudinal brown bands which anteriorly expand laterally forming transverse extensions. The bands outline a gray area which includes two prominent dark brown kidney shaped spots in the anterior portion of the prescutellar depression. Scutellum gray, somewhat darker medially. Legs brown, banded; femora I and II with subapical lighter annulations, femora III uniform brown, tibiae I and II with subbasal annulations, tibiae III with both subbasal and subapical ones. Abdomen brown; spermathecae not suitable for study.

Wing (fig. 1) about 1.00 mm. long and .42 mm. wide, sparsely provided with macrotrichia in the distal portion particularly in cells R_5, M_1 and M_2. These three cells with two light spots each. Distal portions of veins M_1 and M_2 with horizontally directed macrotrichia; the latter vein separates the posterior light spots in cells M_1 and M_2. Cell Cu_1 with one light spot. Inner borders of veins Cu_1 and Cu_2 light. Anal cell with two or three light spots. Distal portion of vein R_{4+5} obliterated. Radio-median cross vein in a dark spot basally.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Camuto Village, Trinidad, July 7 and 9, 1941, resting on walls of a stable. The types were selected from a series of specimens.

Culicoides trinidadensis Hoffman

Culicoides trinidadensis Hoffman, Amer. Jour. Hyg., Vol. V, p. 286, 1925.
Culicoides trinidadensis Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.

Distribution: Known only from Trinidad. A further record of this species in Trinidad is Stubal's Bay, July 4, 1941, a series of females taken from a light trap.

Culicoides inamollae Fox & Hoffman

Culicoides inamollae Fox & Hoffman, Puerto Rico Jour. Pub. Health and Trop. Med., Vol. XX, p. 110, 1944.

Distribution: Known only from Puerto Rico.

Remarks: In the original description it was stated that the legs of this species are without lighter annulations. A re-examination revealed the presence of subbasal and subapical annulations on the hind tibiae, at least.

Culicoides diabolicus Hoffman

Culicoides diabolicus Hoffman, Amer. Jour. Hyg., Vol. V, p. 294, 1925.
Culicoides diabolicus Da Costa Lima, Inst. Oswaldo Cruz Mem., Vol. XXXII, p. 415, 1937.
Culicoides diabolicus Macfie, Ann. and Mag. Nat. Hist., Vol. XX, p. 9, 1937.

Distribution: Described from Panama and reported from Trinidad by Macfie. In the collection there is a specimen mounted on two slides bearing the following data: "Cabima, Panama, May 25, 1911, A. Busck Coll."

Culicoides painteri n. sp.

Diagnosis: A moderate sized species the female of which is about 1.3 mm. long, yellowish brown in color, without a distinctive mesonotal pattern, with legs uniform in color, and definite wing markings. The distal portion of vein R_{4+5} is obliterated and the first radial cell is parallel to the costa.

Description: Female. Head dark brown. Eyes and antennae not suitable for study. Third palpal segment large and swollen at the middle. Second palpal segment shorter than the third; fourth and fifth segments subequal.

Mesonotum yellowish brown without a distinctive design in the pinned specimen available which apparently has been on a pin for almost twenty years and is in poor condition. Scutellum concolorous with the mesonotum. Legs unbanded, yellowish brown in color. Abdomen brown; spermatheca not suitable for study.

Wing (fig. 10) about 1.00 mm. long and .40 mm. wide, with very few macrotrichia. Cell R_5 with two light spots. Cell M_1 and cell M_2 with two light spots. Vein M_2 distally obliterated and replaced by horizontally directed macrotrichia, basally it separates the posterior light spots in cells M_1 and M_2. Cell Cu_1 with one light spot, the inner borders of veins Cu_1 and Cu_2 light. Anal cell with three light spots. Subcosta and posterior portion of the radius obliterated. Distal portion of veins R_{4+5} obliterated, located in a light spot. Radio-median cross vein in a small dark spot basally.

Type Material: Female holotype (mounted in balsam on a slide) and female paratype (pinned specimen) from Puerta Castilla, Honduras, April 20 and 29, 1926, collected by R. H. Painter.

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Platts, N. G., Shields, S. E., and **Hull, J. B.** 1943. Diking and pumping for control of sand flies and mosquitoes in Florida salt marshes. Jour. Econ. Ent., XXXVI, 409–412.

Shields, S. E., and **Hull, J. B.** 1943. The seasonal incidence of sand flies in Florida. Jour. Econ. Ent., XXXVI, p. 625.

U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine. 1938. "Sand flies" and "Punkies." Mimeograph circular E-441.

[3]Other references may be found in the systematic discussion.

SIMULIDOS DEL NUEVO MUNDO, by LUIS VARGAS. Monografia 1 del Instituto de Salubridad y Enfermedades Tropicales. 241 pages, 10 plates. Mexico, D. F., 1945.

The first sixty-eight pages of this publication are devoted to the bionomics of the insects, including a discussion of economic importance, morphology, life cycle, methods of rearing and predators and parasites. This part contains all of the ten plates. The remainder is a systematic survey of unusual organization. It includes a few pages of general discussion followed by a brief historical section summarizing the classifications proposed by Enderlein, Twinn and Rubzov. The second division lists the genera alphabetically, with reference to subfamilies and tribes, brief bibliographies, and a statement of the genotypes. The last are indicated simply as type, without comment on the method of fixation. The third section lists the species alphabetically with synonymy, brief bibliographies, location of types and distribution. All species are assigned to the genus *Simulium*. Part IV lists the species by countries, Part V is an index to generic and specific names, and Part VI is a bibliography of seventeen pages.—A. W. L.

THE GENUS BANDARA BALL
(Homoptera: Cicadellidae)

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Genus **Bandara** Ball

1931. Bull. Brooklyn Ent. Soc. 26: 93.

This is a small group of golden yellow leafhoppers, closely related, and intermediate between *Eutettix* and *Mesamia*. Three species, *B. johnsoni* (V. D.), the genotype; *animana* (Ball) and *aurata* (Ball) have been described and three additional species are described here.

B. animana (Ball) is represented by the single male holotype in the U. S. N. M. Collection and has not been examined. The description indicates that it is quite distinct from the species treated here.

An interesting additional character is the secondary seta, occasionally more than one, on the antenna, which emerges at the base of the third segment.

Through the kindness of Dr. C. F. W. Muesebeck and Dr. R. H. Beamer material from the National Museum and from the University of Kansas collections was included in this study.

KEY TO BANDARA

1. Elytra with pale rounded spots 2
   Elytra unicolorous ..... **aurata**
2. Aedeagus in male narrow, split at apex; last ventral segment in female with prong either side of a median notch 3
   Aedeagus broad; female segment with median portion produced 4
3. Aedeagus in lateral view short, straight, distinctly bifid apically; in female segment deeply incised at middle ..... **johnsoni**
   Aedeagus in lateral view bent dorsad near apex; apical prongs appressed; median incision in female segment shallow ..... **curvata**
4. Pygofer process in male long, heavy, straight; female segment with median portion broadly produced ..... **inflata**
   Pygofer process short, stout and spiny; female segment with narrow notched median projection ..... **parallela**

Bandara johnsoni (V. D.)

Eutettix johnsoni Van Duzee, Can. Ent. 26: 136–7, 1894.

Described originally from specimens collected in Philadelphia, Pa. Specimens have been examined from Conn., Maine, Md., Mass., Miss., N. J., N. Y., Ohio, Tenn. and Virginia.

The more complete description of the genitalia will supplement Van Duzee's excellent description.

Female.—Last ventral segment one-fourth longer than broad, with median longitudinal carina; posterior margin with sides cut out, straight, incised at middle one-fourth or more length of segment, a small prong either side of incision not extending far beyond segment.

Male.—Valve broad, triangular, apex truncate; plates broad and short, narrowed on apical third to blunt apices; pygofers short and stout, a short narrow spike on ventral edge; styles narrowed to long, blunt chitinized finger apically; aedeagus with almost semi-circular base, lower edges narrowed to sharp lateral spines; shaft slender, in ventral view straight, parallel-sided to apical third where it is distinctly bifid, prongs well separated; in lateral view straight, a rather broad dorsal projection near middle extends back even with base, this projection is a third longer than broad and more heavily chitinized on ventral surface. The narrower base and curved, distinctly bifid aedeagus distinguish this from *B. curvata* n. sp.

Length: male 4.5–4.75 mm.; female 5–5.5 mm.

Bandara curvata n. sp.

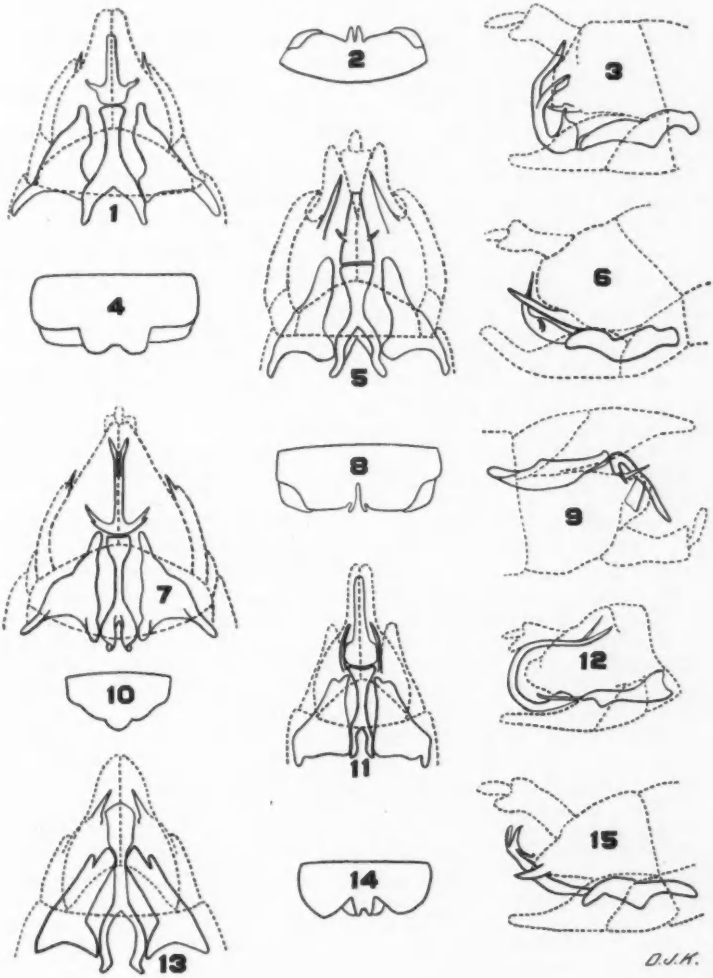
Resembling *B. johnsoni* (V. D.) very closely in color pattern, usually a little smaller, but with distinct genitalia in both sexes. The distribution is more generally southern and western than in *johnsoni*.

Vertex sloping, slightly longer at middle than next to eye, anterior margin forming a distinct ridge in lateral view. Pronotum slightly broader than head; more than twice as broad as long. Anterior margin evenly rounded, posterior margin almost transverse. Elytra long, broad, apices rounded, venation distinct.

Color: Vertex creamy yellow, six black dots in pairs on anterior margin, median pair close together, outer pairs either side of ocelli, outermost dots next to black eyes; disc golden; posterior margin with four creamy transverse yellow spots, median larger, lateral triangular next to eyes. Pronotum golden with median narrow yellow stripe from base almost reaching anterior margin, a pair of lateral broader stripes extending beyond middle and several pale spots below eye. Scutellum golden with pale triangular areas either side of dark impressed median line, and apex pale. Elytra golden, darker in male, subhyaline, with distinct pale spots as follows on each: three small round spots evenly spaced along suture, one at middle, others half way between it and humeral angle; humerus along claval vein; and two small spots on anterior disc. Corial and apical pale spots are larger and more diffuse toward the hyaline costa and form three irregular transverse bands; anterior starting opposite apex of clavus, median just anterior to crossveins and posterior across anterior discs of apical cells. In the male, dark brown points appear at apex of clavus, inner apical crossveins and outer veins in costal margin. Below pale yellow, spines on hind legs darkened at base; wavy black line below apex of head broken at middle and narrowed below ocelli.

Female[1]*:* Last ventral segment short, with a median longitudinal carina, lateral angles incised, median posterior margin with pair of long projecting teeth, incision dividing them scarcely deeper than margin. Pygofer and ovipositor stout, short, stout bristles either side of ovipositor.

[1]Drawings for *Eutettix* (*Mesamia*) *johnsoni* Ball, Proc. Dav. Acad. Sciences 12: 66, pl. 3, figs. 8b, 8c, probably refer to this species.



Figs. 1–15. *Bandara curvata* n. sp. 1–3; *inflata* n. sp. 4–6; *johnsoni* (V. D.) 7–9; *aurata* (Ball) 10–12; *parallela* n. sp. 13–15.

Male.—Valve bluntly triangular; plates broad at base, narrowed to rounded apices on apical third; styles blunt, heavily chitinized; pygofer with short stubby process on inner margin, sometimes bluntly toothed; aedeagus in ventral view with broad rectangular base, a dorsally curved prong from each lower outer angle; shaft long and narrow, parallel-sided to apical third where it is split, but the parts usually remain appressed, seldom as widely separated as in *B. johnsoni*. In lateral view the apical third is curved dorsad at somewhat less than a right angle, the apex bent slightly down, a thin dorsal process, chitinized more heavily on its ventral margin, arises at about half length of shaft and extends back parallel with and as far as the apex.

Length: male, 4.5 mm.; female, 5 mm.

In the collection of The Ohio State University: Male *holotype*, Delaware Co., Ohio, Sept. 9, 1945, D. J. & J. N. Knull; *allotype*, Delaware Co., Ohio, Sept. 9, 1943, D. J. & J. N. Knull; paratypes from Ohio: Clyde, Aug. 26, 1934, Whittington, A. C. Miller Collection; Champaign Co., Aug. 31, 1931, E. P. Breakey; Fairfield Co., June 16, 1945; and Hocking Co., Sept. 3, 1939 and Sept. 14, 1944, D. J. & J. N. Knull. From Iowa: Ames, Aug. 13, 1896, Experiment Station, Aug. 25, 1897 and Sept. 10, 1895, H. Osborn. From Mississippi: Agr. College, July 20, 1920, A. McIntosh; Durant, June 10, 1933; Heidelberg, June 6, 1934, *Fraxinus:* Leland, May 30, 1933; and Okoloma, June 14, 1934, all D. W. Grimes. From Tennessee, Great Smoky Mt. Nat. Park, June 7 and 21, 1942, D. J. and J. N. Knull, on persimmon.

Paratypes in Collection of the University of Kansas: Prattsburg, Ga., July 25, 1930, R. H. Beamer; Magnolia, Tenn., Feb. 4, 1915; Clarkesville, Tenn., Aug. 13, 1914; Arlington, Va., Sept. 19, 1943, R. H. Beamer.

Paratypes in U. S. N. M. Collection: Cuthbert, Ga., May 16, 1916, W. D. Pierce; Hardison Co., Ga., June 26, 1940, *Prunus angustifolia*, Turner; D. C., July 9, 1886, T. Pergande; Glenn Echo, Md., Summer 1922, J. C. Bridwell; Plummers Id., Md., July, 1907, Wm. Palmer; Md.; Hamilton Co., Tenn., May 28, 1939, Turner; Nelson Co., Va., July 19, 1924, W. Robinson; Vienna, Va., Sept. 20, 1932, J. C. Bridwell.

Bandara inflata n. sp.

Large, in general form and color pattern very similar to *johnsoni* and *curvata*, the color is generally more orange gold, white spots small and distinct on clavus; outer edges of elytra becoming almost entirely hyaline, pale bands broader; and in most specimens the scutellum is bright yellow except for golden basal angles.

Female.—Last ventral segment truncate and produced on median third in rather angulate lobe, indented at middle.

Male.—In ventral view valve short, obtusely triangular; plates broad on basal two-thirds, narrowed and slightly divergent apically, exceeding pygofer; aedeagus broad on basal half, with a pair of short spines curved down near base, and apex which is curved dorsad is divided forming two attenuate divergent spines; pygofer rounded, a long heavy spine on ventral edge reaching almost to apex of plate; styles broad, blunt and heavily chitinized.

Length: Male, 5 mm.; female, 5.5 mm.

Male *holotype*, Franklin Co., O., Aug. 10, 1931, E. P. Breakey; *allotype*, Fairfield Co., O., July 10, 1945, D. J. & J. N. Knull; *paratypes*, Worthington, Brown Fruit Farm, O., Aug. 21, 1928; and Tryon, N. C., light, July 20, W. F. Fiske. These are in the Collection of the Ohio State University. One male *paratype* in U. S. N. M., Raleigh, N. C., mid-July, 1909.

Bandara parallela n. sp.

A small, dark form with parallel-margined vertex. Some males are brown with a dark dorsum which shows through the elytra. Some specimens have an indication of dark arcs on face. In respect to general structure and color pattern it closely resembles *B. curvata*.

Female.—Segment short with three lobes of equal length, lateral broad, median narrow and incised about one-third its length.

Male.—Plates broad, gradually tapered to blunt apices, valve obtusely triangular, a little more than one-third length of plates, pygofer short, not much exposed in ventral view, exceeded by plates, a unique heavy, sharp-pointed process on posterior ventral margin projecting and covered except for apex by a thick hairy coat. Aedeagus broad in ventral view, curved dorsad toward apex, two pairs of delicate processes project from lateral edges near apex, anterior turns sharply up close to shaft, then latero-dorsad apically; posterior is broader at base, bent almost at right angle to shaft, and turned up at apex. Styles blunt tipped and heavily chitinized.

Length: Male, 4.25 mm.; female, 4.5–5 mm.

Male *holotype*, Hocking Co., O., Sept. 5, 1945; *allotype*, Fairfield Co., O., July 10, 1945; *paratypes*: Delaware Co., O., Sept. 1, 1944, all D. J. & J. N. Knull; Orono, Me., Aug. 6, 1913, H. Osborn; Ames, Ia., Sept. 3, 1892, H. Osborn; A. & M. College, Miss., May 29, 1930, R. I. Horst. These are in the Collection of The Ohio State University. *Paratypes* in the U. S. N. M. Collection: Catons Bush, Sept. 25, Baker Coll.; Forest Glen, Md., Sept. 15, 1915, O. Heidemann; Glen Echo, Md., summer, 1922, J. C. Bridwell; and Washington, D. C., No. 2059. Collection of the University of Kansas: Clarkesville, Tenn., Aug. 8, 1915; Douglas Co., Kans., June 21, 1928, P. B. Lawson; Fulton, Miss., July 14, 1930, R. H. Beamer; Prattsburg, Ga., July 25, 1930, L. D. Tuthill.

Bandara aurata (Ball)

Eutettix (*Mesamia*) *aurata* Ball, Can. Ent. 41: 81–2, 1909.

This small golden species was described from a single female from Washington, D. C. It differs from other *Bandara* species in that the elytra are unicolorous. In some specimens examined, particularly in males, the dark coloring of the head is very pronounced.

Female.—Last ventral segment long, triangular, longitudinal carina at middle, gradually produced from lateral margins to small rounded lobe at middle.

Male.—Valve short, blunt, triangular; plates long, slender, narrow on outer half; pygofers short, stout, with a weak spine on ventral margin extending well beyond pygofer and curved in slightly. Styles with apices notched, inner lobe produced finger-like; aedeagus with base almost square, shaft very long, narrow, curved evenly forming a large, more than complete semi-circle, apex divided into two long divergent spines, apices extending beyond base in lateral view.

Length: Male, 4–4.25 mm.; female, 4.5 mm.

In The Ohio State University Collection: Licking Co., O., Aug. 5, H. Osborn; Franklin Co., O., Aug. 10, 1931, E. P. Breakey, *Acer*; Carolinas, June 19, 1928, D. M. DeLong; Durant, Miss., June 10, 1934, D. W. Grimes, *Crataegus*.

INSECT DIETARY, by CHARLES T. BRUES. pp. xxvi+466, 22 plates, 68 text figures. The Harvard University Press, 1945. Price $5.00.

The name of the author is advance notice of the comprehensiveness of his work. Although it is not a large volume in actual bulk, it covers an incredible amount of factual material in extremely readable form—readable, that is, to a biologist. The reviewer, at least, suspects that the layman might bog down in its uninhibited scientific vocabulary, although he should appreciate from one point of view or another such items as the comparison of a rigidly monophagous insect to a "teetotaler who would die of thirst in the midst of aqueous liquids defiled by the taint of one-half percent alcohol."

It would be futile to attempt a summary of the contents of such a book. Its chapters cover a survey of the abundance and diversity of insects, types of food habits and their relation to structure and environment, herbivorous insects, gall insects, fungi and microbes as food and symbiosis with microorganisms, predatory insects, parasitism, external parasites, internal parasites and insects as food. Each chapter has an ample bibliography and the book concludes with separate indices to authors and subjects.

The writer shows in his foreword a nice appreciation of trends in biological science, expressed with such facility that it lightens the end of a busy day. A small example says that "Entomologists can speak with fervor of the intricacies of taxonomic investigation. Among all biologists, they seem to have made the worst mess of it, characterizing so many families, genera and species that they have far outstripped the whole field of their taxonomist brethren. This is not really their fault; it is merely a feeble attempt to sort out the avalanche of insects that Nature has lavished on the Earth." But read it yourself. However much you may know about insects you are sure to learn a lot more and learn it with enjoyment if terms like monophagous and oligophagous and hypogaeic do not disturb the serenity of your reading.—A. W. L.

A REVIEW OF THE NEARCTIC LEPIDOSTOMATIDAE (TRICHOPTERA)

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The males of this caddis fly family are unusual in the number of very odd structural developments of many appendages. Noteworthy of these secondary sexual characters are enlargement or folding of the wings, plate-like expansion of some of the leg segments, oddly shaped branches, grooves or twisted regions of the basal antennal segment, and many diverse shapes assumed by the maxillary palpi. None of these characters has any similar counterpart in the female. Until recent years, these unusual male structures were used as a basis for generic definition. So abundant are these characters that in 1936 about 15 genera had been erected for the reception of the less than 25 Nearctic species recognized in the family at that time. Few of these genera or species were recognizable in the female sex.

Since that time the association of larvae and adults of several of these forms has shown that the immature stages offer no characters which corroborate the generic divisions used for the males. Further study of the North American species showed that the male genitalia provided a number of characters for grouping the species into a few fairly well marked groups. In many cases each of these groups contained forms with quite different modifications of wings, antennae, or palpi, and it appeared fairly clear that these latter characters had little relation to the phylogenetic grouping of the species within the family. In an effort to substantiate these findings, a detailed study of the female genitalia was undertaken. It was found that the spermatheca presented a series of characters which grouped the females in exactly the same way that the male genital characters grouped the males.

It seems evident from this that a large number of the genera in this family based on the strange modification of the males do not represent basic groupings of the species and that many of them should be synonymized. The result of these remarks was indicated previously by Ross (1938 and 1944); in the latter report only two genera, *Lepidostoma* and *Theliopsyche*, have been recognized for reception of the Nearctic species. In this paper, I have made a preliminary segregation of the species of *Lepidostoma* into what appear to be fairly well defined groups based primarily on the genitalia of the two sexes.

At the present time a large number of generic names are employed for members of this family for other regions of the world. Many of these genera are based on the same type of secondary sexual characters as have been used for the North American species. It is probably that, at least to some extent, the same situation exists among these as has been found in the North American species, and that some modification of the generic concept of these forms will ultimately be necessary. Such a study, however, will have to be based on a correlation of the

male and female genitalia and preferably the larvae also. Since this material is not available to me for study, I have not attempted in this paper to treat names other than those concerning North American species.

To date larvae of only *Lepidostoma* are known, *Theliopsyche* larvae never having been associated with the adults. An examination of several reared species of *Lepidostoma* and many unassociated collections of larvae of the genus has failed to show more than a few slight color differences between species. This paper, therefore, deals only with the adult form.

The purpose of the present paper is (1) to offer a key to the males and identified females in the family, (2) to summarize references to the original descriptions and to additional published illustrations of diagnostic characters, (3) to present drawings of the male genitalia for certain species which have not previously been illustrated, and (4) to describe the hitherto unexplored characters of the female genitalia of the family for those species which I have available.

In the drawings to the male genitalia, the aedeagus has been omitted. This structure is remarkably uniform throughout the genus *Lepidostoma* and consists of a curved tube with a pair of dorsal sclerotized blades appressed to it. This structure offers some differences between certain species but presents no characters as striking as those exhibited by the claspers and tenth tergite. In previous papers I have referred to the sclerotized portion of the internal female genitalia as the bursa copulatrix. It seems much more logical to suppose that this sclerotized portion is part of the true spermatheca and is so termed in this paper.

The family is treated here as defined by Ross in 1944.

Types of new species described in this paper are deposited in the collection of the Illinois Natural History Survey, unless otherwise noted.

KEY TO GENERA

1. Head with posterior warts fairly wide, triangular or curved; 8th sternite of male without flap-like mesal processes; female with spermatheca either wide or ovate, figs. 20–34, and with subgenital plate varied in structure but never with two pairs of membranous "horns" ..... **Lepidostoma**
   Head with posterior warts long, narrow and straight; male with a long flat mesal flap on 8th sternite, fig. 37B; female with spermatheca triangular, produced into a long apical point, figs. 35, 36, and with two pairs of membranous "horns" at the apex of the subgenital plate ..... **Theliopsyche**

Genus **Lepidostoma** Rambur

The synonymy of this genus has been given by Ross (1944: p. 258). There the synonymy is listed without attempt to place the various names according to species groups. The generic names are listed here under the species groups in which they belong.

SYNOPSIS OF SPECIES GROUPS

Togatum Group.—Males with 10th tergite produced into a pair of simple arms arising laterally, and with claspers elongate, bearing a clavate basal process and a short pointed or cuneiform preapical process, the entire clasper arcuate from ventral view, figs. 1, 2; female with

spermatheca wide, fig. 20B, overlapped by or fused with its connecting folds and without a distinct sclerotized ventral bridge.

Includes *carolina*, *tibialis*, *knowltoni*, and *togatum*. To this group belong the genotypes of *Lepidostoma* Rambur, *Pristosilo* Banks, *Neuropsyche* Carpenter, and *Oligopsyche* Carpenter.

Latipennis Group.—Male genitalia with elongate claspers having a spatulate basal lobe, and a long sinuate mesal lobe, fig. 3. Female unknown. The position of this group is doubtful. *Latipennis* is the genotype of *Notiopsyche* Banks.

Cantha Group.—Male with elongate claspers bearing only a finger-like basal process; female with spermatheca fused with supporting bands but with a definite sclerotized ventral bridge, fig. 21. Contains only one species, *cantha*. The male genitalia are similar to the following group but the spermatheca is quite different.

Pluviale Group.—Males with elongate claspers bearing a finger-like basal process and a short subapical mesal process, 10th tergite usually armed with spines; female genitalia with spermatheca completely hidden beneath supporting folds, fig. 22, of an unusual bowl-like shape and with the ventral bridge near its apical margin. Contains *pluviale*, *rayneri*, and three new species described below.

Modestum Group.—Male genitalia having the basal process of the clasper elongate, overlaying the remainder of the clasper and expanded into a wide flat apex; female genitalia with spermatheca appearing suspended from ventral bridge, the spermatheca wide and somewhat triangular, fig. 23. Contains *modestum*, *swannanoa*, *lydia*, and *ontario*. *Modestum* is the genotype of *Atomyia* Banks.

Unicolor Group.—Male genitalia with short claspers exhibiting a great variety of shapes; female genitalia, figs. 24–26, having spermatheca ovoid and appearing suspended from ventral bridge; apical tergites without large areas of hair. Contains the largest number of species of any group. To this group belong the genotypes of *Nosopus* McLachlan, *Olemira* Banks, *Alepomyia* Banks, *Alepomyiodes* Sibley, *Arcadopsyche* Banks, and *Jenortha* Milne.

Vernalis Group.—Male genitalia various with 7th and 8th tergites, fig. 19, having large patches of long hair or 9th tergite with a large patch of setae, fig. 17; female genitalia with spermatheca as in the *Unicolor group*, but the 9th tergite with a pair of setal patches, fig. 34A. Contains *vernalis*, *griseum*, *sackeni*, *liba*, and *sommermanae*. To this group belong the genotypes of *Mormomyia* Banks and *Phanopsyche* Banks.

KEY TO NEARCTIC SPECIES

1. Maxillary palpi 1- to 3-segmented (males) 2
   Maxillary palpi 5-segmented (females) 35
2. Seventh and eighth tergites each with a pair of conspicuous ovate tufts of long hair, fig. 19; ninth tergite usually with a pair of hair tufts, fig. 17 3
   Seventh and eighth tergites with only scattered, well-separated hairs; ninth tergite never with hair tufts 7
3. Ninth tergite greatly enlarged and bulbous, fig. 19, overhanging lateral lobes of tenth tergite ..... **sackeni**
   Ninth tergite short, as in fig. 17, lobes of tenth tergite connecting with its posterior margin 4

4. Ninth tergite with small hair tufts; tip of claspers narrowed and curved mesad; lateral lobes of tenth tergite large, their lower margin bearing two large sclerotized rods directed postero-mesad, fig. 17 ..... **griseum**
   Ninth tergite with very large hair tufts; tip of claspers oblique; lateral lobes of tenth tergite small, without such processes (Ross, 1938*c*: fig. 90) 5
5. Mesal lobes of tenth tergite forming a pair of sclerotized outcurved rods (Ross 1938*c*: fig. 90); claspers with apical margin nearly transverse, serrate ..... **vernalis**
   Mesal lobes of tenth tergite moderately large but membranous and inconspicuous (Ross 1941*b*: fig. 97A); claspers with apical margin decidedly oblique 6
6. Basal spur of clasper evenly curved and smooth, curving high above clasper base (Ross 1944: fig. 883) ..... **liba**
   Basal spur of clasper angled and serrate, fig. 18, rising only little above clasper base ..... **sommermanae**
7. Front wings with entire costal cell reflexed, turned back over the rest of the wing so that it forms a flap covering at least the entire subcostal cell 8
   Front wing with at most only a small basal portion of costal cell reflexed, or the reflexed area very narrow 14
8. Claspers short and thick, the apical lobes pointed (Betten 1934: pl. 64, figs. 1–5) 9
   Claspers long and slender, fig. 4, the apical lobes expanded 10
9. Lobes of tenth tergite with dorsal spur much longer than ventral spur, and projecting postero-dorsad, fig. 14 ..... **americanum**
   Lobes of tenth tergite with dorsal spur shorter than ventral lobe and projecting antero-dorsad, fig. 15 ..... **costalis**
10. Lobes of tenth tergite with dorsal and ventral spurs fused to form an anchor-like structure, fig. 6 ..... **ormae**
    Lobes of tenth tergite with dorsal and ventral spurs well separated, fig. 4 11
11. Tenth tergite having the ventro-lateral spur forming a broad, flat, divergent flange, fig. 5 ..... **lotor**
    Tenth tergite having the ventro-lateral spur with only the sharp apex projecting laterad (Ross 1941*b*: fig. 95A) 12
12. Tenth tergite with ventral and dorsal spurs both small and apical (Ross 1941*b*: fig. 96) ..... **rayneri**
    Tenth tergite with ventral spur long, dorsal spur not at apex, either small (Ross 1941*b*: fig. 95) or large, fig. 4 13
13. Tenth tergite with upper portion of lobes projecting posterad, lateral aspect plate-like, dorsal aspect pointed, and bearing only an inconspicuous spur (Ross 1941*b*: fig. 95) ..... **pluviale**
    Tenth tergite with upper portion of lobes projecting chiefly dorsad, and bearing a long spur on the back part, fig. 4 ..... **rhino**
14. Claspers with dorsal process long, expanded at apex into an ovate lobe which overlies, or extends beyond, the apex of the main part of the clasper (Ross 1939*a*: figs. 9, 11) 15
    Claspers with dorsal process shorter, fig. 10, and usually pointed at apex, fig. 13 18
15. Tenth tergite with a pair of long flat arms, each arising at the side of the base of the tergite and extending in a sweeping arc beyond its tip; dorsal process of clasper long and stout, extending beyond remainder of clasper (Ross 1941*b*: fig. 98) ..... **ontario**
    Tenth tergite without definite lateral arms 16
16. Tenth tergite parallel sided, its apical margin with only a semi-circular mesal incision, the two apical lobes short and rounded laterad (Ross 1939*a*: fig. 9) ..... **lydia**
    Tenth tergite with apical portion elongate and tapering, with a mesal cleft nearly to base, (Ross 1939*a*: fig. 11) 17
17. Apical lobes of tenth tergite long, narrow, smooth, and whip-like (Ross 1938*a*: fig. 93) ..... **modestum**
    Apical lobes of tenth tergite wider and serrate along the margins (Ross 1939*a*: fig. 11) ..... **swannanoa**
18. Base of tenth tergite with a pair of heavy ventral spurs, each arising at the lateral margin, curving beneath the tergite and then back, the spur tip

finally projecting from beneath the lateral margin of the tergite; claspers long and slender, with only a single process which is finger-like and projects dorsad from the base of the clasper (Ross 1941*b*: fig. 94)..... **cantha**

Base of tenth tergite without such a pair of spurs; claspers frequently short and with two or three processes (Ross 1938*c*: fig. 92)..... 19

19. Claspers with basal process very short, scarcely projecting above clasper base, fig. 13..... **roafi**

Basal process of claspers projecting considerably above clasper body, figs. 3, 7, 10, 12, 16..... 20

20. Apex of claspers with a comb-like brush of spines chiefly dorsal in position, and a sinuate meso-basal process with an oval head, fig. 3; preapical process long and near middle of clasper. Wings very wide (Betten 1934: pl. 65, fig. 9)..... **latipennis**

Apex of claspers with a dense brush ventral in position, figs. 7, 10; meso-basal process without head, figs. 7, 10; preapical process short and near apex of clasper..... 21

21. Tenth tergite divided into a pair of long, simple arms, with neither spurs nor sclerotized teeth (Ross 1938*a*: fig. 117); claspers with clavate basal process and a short mesal process at apex, figs. 1, 2..... 22

Tenth tergite not forming long arms, usually with spurs or teeth, fig. 7, or an angular ventral notch, fig. 8; claspers with basal process, dorsal lobe and usually an apico-mesal process, all finger-like, figs. 12, 16..... 25

22. Arms of tenth tergite close together; preapical process of claspers wide and expanded at tip (Ross 1938*c*: fig. 92)..... **carolina**

Arms of tenth tergite separated at base by a pair of membranous lobes (Ross 1938*a*: fig. 117)..... 23

23. Base of clasper with no lobe on ventral margin of mesal side, fig. 1..... **tibialis**

Base of clasper with a finger-like lobe on ventral margin of mesal side, fig. 2..24

24. Ventro-mesal process at base of clasper short, set out some distance from body of clasper, its base rounding gracefully into that of clasper body, fig. 2 (also Ross 1939*a*: fig. 117); antennal scape greatly twisted.... **knowltoni**

Ventro-mesal process at base of clasper long, subparallel with, and close to, clasper body, (Betten 1934: pl. 65, figs. 1–8); antennal scape with even outline..... **togatum**

25. Lobes of tenth tergite with tip projecting as a very slender, finger-like lobe; tip of clasper forming a mesal, thumb-like process, fig. 8..... **frosti**

Lobes of tenth tergite with tip shorter or thicker, figs. 7, 10; claspers various..26

26. Each lobe of tenth tergite ending in a fairly long, ovate, concave, sloping portion, with a single dorsal tooth near base; lateral aspect of claspers with apex massive and truncate, fig. 16..... **jewetti**

Lobes of tenth tergite shorter, apical lobes not of this type; claspers tapering towards tip, figs. 7, 10..... 27

27. Lateral aspect of claspers with apex ending in a semi-truncate, blunt tip or with a button-like ventral lobe, figs. 7, 10..... 28

Lateral aspect of claspers with apex tapering to a sharp, pointed tip, fig. 12..30

28. Each lobe of tenth tergite with a short dorsal spine, and with ventral margin incised to form a sharp ventral and apical lobe, fig. 7..... **unicolor**

Lobes of tenth tergite without spines or incisions, their apex tapering to a narrow, short tip, fig. 10 (also Ross 1938*a*: fig. 120); wings of moderate width and moderately hairy, but without scales..... 29

29. Dorsal aspect of tenth tergite with lateral margins diverging markedly beyond middle; lateral aspect with tip forming a large triangular lobe; large tubercles at base of setae; fig. 10..... **knulli**

Dorsal aspect of tenth tergite with lateral margins nearly parallel or slightly converging at tip; lateral aspect with a small lobe which is frequently finger-like; small tubercles at base of setae, fig. 9, (Ross 1938*a*: fig. 120).. **strophis**

30. Each lobe of tenth tergite with two sharp, projecting, up-curved teeth on lower portion of apex (Ross 1938*c*: fig. 91)..... 31

Lobes of tenth tergite without such teeth..... 32

31. Projecting teeth on tenth tergite of same size and shape (Betten 1934: pl. 62, figs. 10, 11)..... **bryanti**

Projecting teeth on tenth tergite different, ventral one long and finger-like and projecting considerably below lobe (Ross 1938*c*: fig. 91)..... **prominens**

32. Lobes of tenth tergite with a sharp dorsal projection (Ross 1938*a*: fig. 119)...33
Lobes of tenth tergite without a dorsal projection, fig. 12.....34
33. Front legs with tibia short and wide, and basitarsus tremendously expanded, fig. 11, both scaled.....**podager**
Front legs with tibia and tarsi cylindrical, similar in general proportion to middle legs, and without scales.....**quercina**
34. Tenth tergite with ventral portion of lateral lobe projecting and narrow, this portion bearing a dorsal row of 6–8 short, sharp, sclerotized teeth; dorsal portion of lateral lobe forming a smooth, round dome (Ross 1938*a*: fig. 118). Antennal scape having a long, meso-ventral, finger-like ramus, and beyond it a hump, the hollow between ramus and hump filled with a dense brush of dark hair and scales; front wings with basal tenth of costal margin reflexed to form a scale-filled pocket.....**cascadense**
Tenth tergite with lateral lobes wide and plate-like, the apical edge with short teeth, fig. 12; dorsal portion not forming a distinct fold. Antennal scape cylindrical, with a shallow ventral scale groove; front wing margin not at all reflexed.....**delongi**
35. Spermatheca more or less pentagonal in shape, with ventral bridge near apex (free end) and bearing a long, sclerotized point, fig. 22.....**Pluviale group**
Spermatheca round, oval, or conical, figs. 20, 21, 23–26, ventral bridge indistinct or near base (attached end).....36
36. Spermatheca conical, fig. 23, the ventral bridge at or beyond base, **Modestum group**
Spermatheca round or oval, figs. 20, 24.....37
37. Spermatheca round or irregular in shape, attached to lateral bands which are prominent and wide in ventral view, figs. 20, 21.....38
Spermatheca oval or vasiform, attached to membranous areas which are not band-like, figs. 24–26.....40
38. Spermatheca nearly round and well set off from lateral bands, fig. 20B.....39
Spermatheca nearly completely fused with ends of lateral bands, fig. 21..**cantha**
39. Dorsal internal plate below ninth tergite flat on top.....**tibialis**
Dorsal internal plate below ninth tergite having a deep longitudinal groove on top, fig. 20A.....**togatum**
40. Ninth tergite with a basal pair of hair-bearing warts, fig. 34A.....41
Ninth tergite without a basal pair of hair-bearing warts, figs. 27–31.....43
41. Ventral bridge of spermatheca projecting as a sharp shelf, fig. 32D....**griseum**
Ventral bridge of spermatheca rounding evenly into apical membranes, fig. 33D.....42
42. Apex of subgenital plate with membranous meson and sclerotized lateral areas, fig. 33B.....**liba**
Apex of subgenital plate with sclerotized meson and membranous lateral areas, fig. 34B.....**sommermanae**
43. Lateral portion of ventral bridge with a pair of sclerotized flaps, fig. 25, **prominens**
Lateral portion of ventral bridge without a pair of flaps.....44
44. Lower side of tenth tergite with a long, narrow, spatulate sclerotized thickening, fig. 27.....**unicolor**
Lower side of tenth tergite without a long thickening.....45
45. Ventral bridge projecting laterad of spermatheca and forming a pair of definite flanges, fig. 24.....**strophis**
Ventral bridge without definite flange-like projections, fig. 26.....46
46. Ninth tergite massive, projecting as far posteriorly as most of tenth tergite, fig. 31.....**costalis**
Ninth tergite ending in a sharp hump beyond which projects much of tenth tergite, figs. 28, 29.....47
47. Lobes of tenth tergite close together at apex and produced into a mesal point, fig. 28.....**cascadense**
Lobes of tenth tergite either truncate, fig. 29, or rounded and well separated at apex, fig. 30.....48
48. Apex of tenth tergite lobes truncate, fig. 29.....**quercina**
Apex of tenth tergite lobes rounded, fig. 30.....**roafi**

Togatum Group

The males of this group have few striking secondary sexual characters. The females of only two species have been associated with the males and these two are very similar in structure.

Lepidostoma togatum (Hagen)

1861. *Mormonia togata* Hagen, Syn. Neur. N. A. 273. ♀.
1897. *Silo pallidus* Banks, Am. Ent. Soc. Trans. 24: 29. ♂.
1899. *Pristosilo canadensis* Banks, Am. Ent. Soc. Trans. 25: 21. ♂.

The male considered as associated with Hagen's female type has been associated on the basis of certain characters of the venation, plus locality, as discussed by Ulmer and Betten. The latter (1934: pl. 65, figs. 1–8) gives excellent illustrations of the species. The female genitalia, fig. 20, are variable in detail but quite constant in general shape. The ventral bridge below the spermatheca is represented by only a membranous fold; in a few individuals this may be somewhat conspicuous and suggests very strongly that this membranous fold is the forerunner of the sclerotized ventral bridge found in some of the other groups.

The species is widely distributed throughout the central and eastern portion of the continent, with records available from the following localities: ARKANSAS—Mammoth Springs. CONNECTICUT—Mt. Carmel, Spruce Bank Spring. GEORGIA—Ringgold, Meadow Lake; Thomaston. KENTUCKY—Livingston, Rock Castle River. MAINE—Bingham; Warren. MICHIGAN—Brevort; Crawford Co., Au Sable River; Douglas Lake; Grayling, Manistee River. MISSOURI—Hollister; Waynesville. NEW YORK—Ithaca; Ogdensburg. NORTH CAROLINA—Cherokee. ONTARIO—Swansea; Thunder Bay. PENNSYLVANIA—Athens, Susquehanna River; Clinton Co., Kettle Creek. QUEBEC—Sherbrooke; St. Lawrence River. SASKATCHEWAN—Waskesieu Lake. TENNESSEE—Gatlinburg. WASHINGTON, D. C. WISCONSIN—Bloomer; Merril, Wisconsin River; Spooner, Namekagon River; Trout Lake.

Lepidostoma carolina (Banks)

1911. *Notiopsyche carolina* Banks, Am. Ent. Soc. Trans. 37: 356. ♂.

This species has been recorded only from the type locality of Southern Pines, North Carolina. Distinctive points of the male genitalia are illustrated by Ross (1938*c*: fig. 92); these drawings were made from a cleared preparation of a paratype. I have seen no females of this species.

Lepidostoma tibialis (Carpenter)

1933. *Neuropsyche tibialis* Carpenter, Psyche 40: 39. ♂, ♀.

To the illustrations in Carpenter's original description, I am adding a ventral view of the male clasper, fig. 1. The ventral mesal lobe of the clasper is represented in this species by only a broad shoulder. The female spermatheca is extremely similar to that of *togatum*, differing

chiefly in that the dorsal sclerotized fold visible beneath the ninth tergite lacks any indication of the mesal trough characteristic of ***togatum***.

The species has been taken only in the vicinity of the Great Smoky Mountain region. Available records include: GEORGIA—Lakemont. NORTH CAROLINA—Bryson City; Nantahala Gorge. TENNESSEE—Elkmont; Gatlinburg; Great Smoky Mountain National Park, Chimney's Camp Ground.

Lepidostoma knowltoni Ross

1938. ***Lepidostoma knowltoni*** Ross, Ill. Nat. Hist. Surv. Bull. 21: 175. ♂.

The twisted antennal scape and the ventral aspect of the clasper, fig. 2, readily identify this species. It is the only western species so far recorded for the group. No females have yet been identified and the species is known from only these three localities: COLORADO—Montezuma Co. MONTANA—Belton, along Flathead River. UTAH—Quinton.

Latipennis Group

This contains only a single species, ***latipennis***.

Lepidostoma latipennis (Banks)

1905. ***Notiopsyche latipennis*** Banks, Am. Mus. Nat. Hist. Bull. 21: 216. ♂.

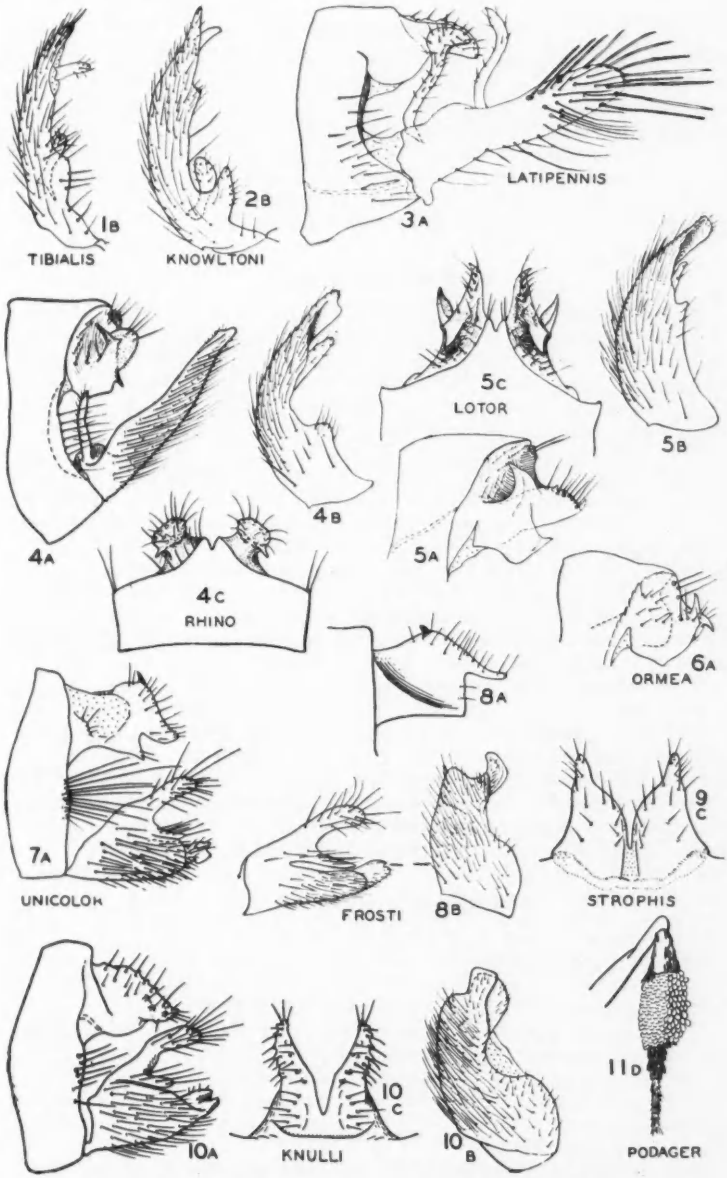
The unusually broad wing of the species illustrated by Banks in his original description and by Betten (1934: pl. 65, fig. 9), is a striking feature of the species. No less striking are the very unusual male genitalia, fig. 3. The tenth tergite is simple; the claspers have a very long, sinuate, capitate basal process and a second long sinuate mesal process arising near the middle. The apex of the clasper is surmounted by a brush of regularly placed, long setae; the ventro-lateral aspect of the clasper does not have the customary brush of hair. The maxillary palpi of the species are also of curious structure. In dried specimens they appear as a single-segmented, finger-like structure, but specimens preserved in fluid show that this is extensile, and may be extended into a long flexible tube, at least half as long as the antennae.

The female of this species has not been identified with certainty. An unidentified female from Georgia which may be this species suggests a close affinity with the ***Togatum*** group, but the association is not established.

The species is known from only scattered localities, as follows: GEORGIA—Roberta. NORTH CAROLINA—Black Mountain. NOVA SCOTIA—Chester Basin.

Cantha Group

This contains only one species, ***cantha*** Ross. The elongate simple clasper of the male genitalia suggests a close relationship with the ***Pluviale*** group, but the spermatheca is more suggestive of an intermediate condition between the ***Togatum*** group and the ***Unicolor*** group.



Figs. 1–11. Details of *Lepidostoma* males: A, lateral aspect of all, or part of, genital capsule; B, ventral aspect of claspers; C, tenth tergite; D, front tibia and tarsus.

Lepidostoma cantha Ross

1941. *Lepidostoma cantha* Ross, Am. Ent. Soc. Trans. 67: 118. ♂, ♀.

The spermatheca, fig. 21, distinguishes the female of this species from any others known in the genus. The body of the spermatheca merges imperceptably with its supporting bands and has a band-like ventral bridge. The ventral groove of the spermatheca is situated near the posterior margin and has an unusually long closed posterior portion.

The species is recorded only from the type locality, Hastings Natural History Reservation, Monterey County, California.

Pluviale Group

The males of all known members of this group have a greatly reflexed condition of the front wing. The anterior portion is very wide and is folded back over the top of the wing, covering a quarter to a third of its surface. The female spermatheca, fig. 22, is extremely peculiar for the genus, and sets off the group indubitably as the most distinctive in the genus. The connecting folds have extended anteriorly and have almost completely overlaid the spermatheca; there is a well marked ventral bridge at the end of these folds and it appears to be at the anterior end of the spermatheca instead of near or above the posterior end as in all the other groups of the genus. The male genitalia are characterized by a long slender clasper having a finger-like basal process, fig. 4. In this regard the *Pluviale* group resembles the *Cantha* group and it is interesting to note that the spermatheca of the *Cantha* group, fig. 21, would have to undergo little more than the migration of the ventral bridge to produce a structure somewhat like that in the *Pluviale* group.

The reflexed front wing presents one of the finest cases of parallel development in the entire family. This same condition was first observed in the species *americanum* and *costalis*, formerly placed in *Olemira*, and originally the members of the *Pluviale* group were also placed in *Olemira*. Both male and female genitalia of *americanum* and *costalis* show definitely that they are typical members of the *Unicolor* group, and that this superficial resemblance of the reflexed front wings is a case of parallel development without phylogenetic significance.

Lepidostoma pluviale (Milne)

1936. *Olemira pluviale* Milne, Studies N. A. Tric. 3: 117. ♂, ♀.

The male genitalia were illustrated by Ross 1941*b*: fig. 95. The female spermatheca is very similar to *rayneri*, no differences having been found to date to separate to species the females of this group.

This species appears to be restricted to the more eastern ranges of the western mountain areas in which it is the dominant member of the genus. The cases of the species appear to be always round and smooth, and of hard texture. I have reared the species on the basis of larvae and mature pupae collected together in many streams in the vicinity of Rocky Mountain National Park, Colorado.

In the original description of the species, a few specimens from British Columbia were listed as paratypes; these specimens do not

belong to this species but to *rayneri*. Rechecked available records of *pluviale* are listed below: COLORADO—Rocky Mountain National Park, Cascade Lodge; Estes Park, Thompson River; West Creek; Granby, Fraser River; Creede. MONTANA—Belton, Flat Head River; Glacier National Park, Logging Creek; Harrison. WYOMING—Jenny Lake, Grand Teton National Park; Green River, north of Pinedale. UTAH—Logan; Brigham Canyon; State Lake County, Mill Creek.

Lepidostoma rayneri Ross

1941. *Lepidostoma rayneri* Ross, Am. Ent. Soc. Trans. 67: 117. ♂, ♀.

The spermatheca of this species is illustrated in fig. 22. There is some variation in its exact shape and the sclerotized piece which proceeds posteriorly from the meson of the ventral bridge. At the anterior end of the spermatheca, there is a somewhat oval membranous fold which varies considerably in shape and definition.

Few records are available for this species, but it appears to replace *pluviale* in the Coastal and Cascade ranges of the western mountains, with records from the following: BRITISH COLUMBIA—Cultus Lake; Lillooet. CALIFORNIA—Mono County, Convict Creek. OREGON—Molalla, Molalla River. WASHINGTON—Cashmere, Wenatchie River.

Lepidostoma ormea n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color brown, legs and venter a lighter shade than the dorsum; antennae and palps very light brown. Wings uniformly infuscate with very light brown. Maxillary palpi appearing one segmented, short and thumb-like, surmounted by an eversible membranous lobe bearing a brush of dense black hair. Antennal scape nearly as long as width of head, the anterior (ventral) margin concave and bearing a dense brush of long yellow hair and shorter black scales. Front wing with the costal and sub-costal cells greatly expanded to form a large flap extending from the base of the wing to the stigma, the flap folded over on to the dorsal surface of the wing and forming a flat pouch which extends back to and overlaps radial sector. The pouch is filled with a series of scales.

Genitalia, fig. 6A, similar in general structure to *rayneri*. Tenth tergite forming a pair of divergent lobes, each bearing at apex a strongly developed spined hook, one spine projecting dorsad, the other ventrad. There is no lobe which extends posterior to these spines. Claspers elongate, with a basal finger-like process, very similar to those in fig. 4A.

Holotype, male.—Heber City, Utah, July 23, 1939, at light, Knowlton and Harmston.

This species is most closely related to *rayneri*. In this latter species the apex of the tenth tergite forms a wide lobe with a dorsal spine and a ventral spine which are well separated. In *ormea* these two spines have apparently come together and fused to form a single anchor-like hook.

Lepidostoma lotor n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color very dark brown, almost black, with legs, palpi, and venter of abdomen

slightly lighter. Wings moderately dark brown, the reflexed scale pocket dark brown and approaching the color of the dorsum. General structure of palpi, flagellum, and wings as described above for ***ormea***.

Genitalia, fig. 5, typical in general shape for group. Tenth tergite divided into a pair of lobes, figs. 5A and C, each lobe bearing near the middle a large dorsal flange-like spur, and, below it, a wide projecting flange with a posterior point. The main portion of the lateral lobe is produced posteriorly into a moderately long pointed structure bearing a dorsal row of setae and a small sclerotized point at its tip. Claspers very similar to fig. 4A, from lateral view; ventral aspect broad, fig. 5B, the apical third tapering rapidly to the tip.

Holotype, male.—Wadell Creek, California, May 15, 1937.

Differences given in the key separate this species from its allies.

Lepidostoma rhino n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color of head and body medium shades of brown; antennae, palpi, and legs, tawny; wings infuscate with yellowish. General structure of scape, palpi, and wings as described above for ***ormea***.

Genitalia, fig. 4, with tenth tergite divided into a pair of lateral lobes, each bearing on the lateral side a long antero-dorsal and a shorter ventral spine, the lobe beyond these spines forming a rounded crown; from dorsal view these lateral lobes appear somewhat button-like, fig. 4C. Claspers elongate with a finger-like baso-dorsal lobe; their ventral aspect, fig. 4B, has the basal third wide, beyond which it narrows suddenly and the apical two-thirds curves more or less evenly to the apex.

Female.—Size and general color typical for male. Structure of palpi and wings simple, as for females of other members of the genus. Spermatheca similar to that of ***rayneri*** (fig. 22B); no distinguishing features have been found to date to separate to species the females of this group.

Holotype, male.—R. Santo Domingo, Rancho San Antonio, 1000 feet elevation, Baja California, Mexico, May 24, 1937, H. J. Rayner.

Allotype, female.—Same data as holotype.

Paratypes.—4 ♂, 4 ♀, same data as holotype.

Differences given in the key separate this species from its allies.

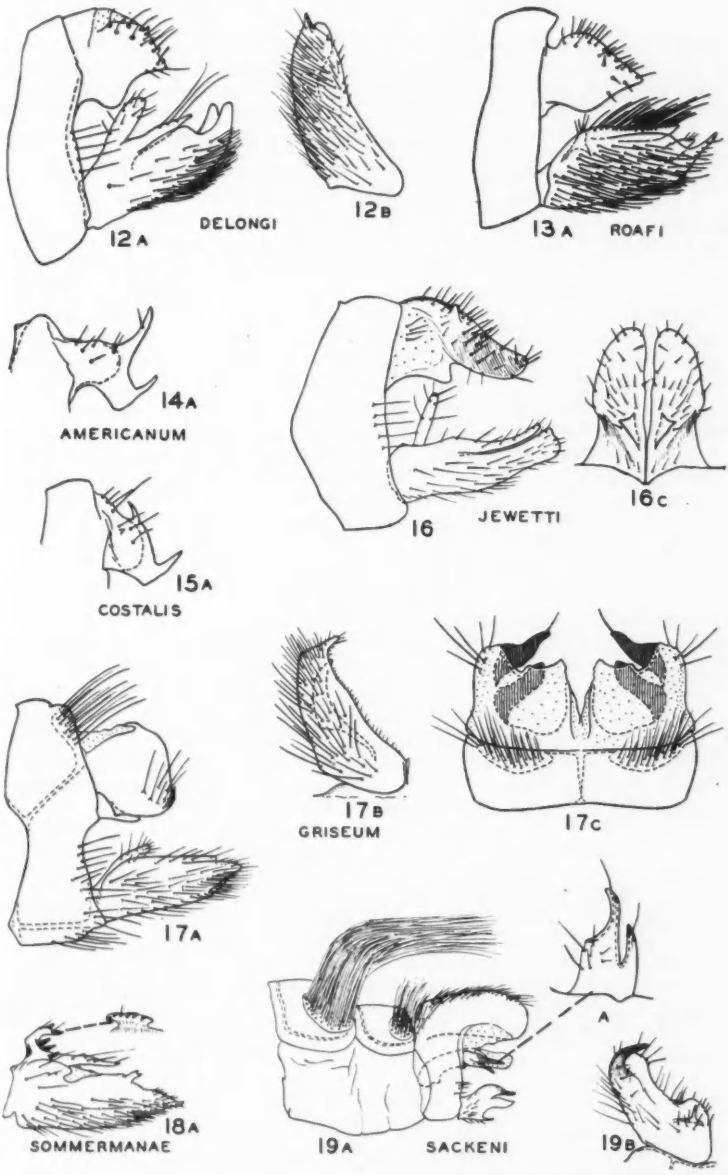
Modestum Group

This group is set off very clearly from others in the genus by the wide, sub-triangular spermatheca of the female, fig. 23B, and the dorsal process of the claspers, which is expanded at the apex, (Ross 1939*a*: fig. 11). Four species described to date belong in this group.

Lepidostoma modestum (Banks)

1905. *Atomyia modesta* Banks, Am. Mus. Nat. Hist. Bull. 21: 217. ♂.

This species has not been recorded since its original description. A more complete description, with illustrations, was presented soon after the original description by Banks (1905: page 12, figs. 21–25). The lobes of the tenth tergite of the male end in a long whip-like tip, illus-



Figs. 12–19. *Lepidostoma*, male genitalia: A, lateral aspect of all or part of capsule; B, ventral aspect of claspers; C, dorsal aspect of tenth tergite.

trated by Ross (1938*c*: fig. 193). Other parts of the genitalia and various adult structures are illustrated by Betten (1934: pl. 62, figs. 1–7). The female of the species has not yet been definitely associated.

Lepidostoma swannanoa Ross

1939. *Lepidostoma swannanoa* Ross, Ent. Soc. Wash. Proc. 41: 69. ♂, ♀.

There is a possibility that this may eventually prove to be the same as *modestum*. The only difference found to date is in the shape of the lobes of the tenth tergite, but the difference seems to be striking and distinctive in the material I have examined. It is unusual, however, that subsequent collecting at Black Mountain, North Carolina, the type locality of both *modestum* and *swannanoa*, has resulted in the capture of only *swannanoa* and it may well be that eventually intergrades may be found which might link these two forms which now appear distinct. The female of *swannanoa* is very similar to that of *ontario*, and the spermatheca appears to differ only in variable details from that illustrated in fig. 23B.

Records of *swannanoa* are scattered almost the length of the Appalachian region, as follows: NEW HAMPSHIRE—Benton, Moosilanke Lake; Glen House, Mt. Washington; Woodstock. NEW YORK—Adirondack Park, Euba Mills and Blue Mountain Lake. NORTH CAROLINA—Black Mountain.

Lepidostoma lydia Ross

1939. *Lepidostoma lydia* Ross, Ent. Soc. Wash. Proc. 41: 70. ♂, ♀.

The female of this species is very similar to others in the group, the spermatheca resembling very closely that of *ontario*. This distinctive species appears to have a somewhat similar distribution to that of *swannanoa*, the records being scattered along the length of the Appalachian system: NEW HAMPSHIRE—Mt. Washington, at Avalanche Creek, Crawford Notch, Cog Railway, Gibbs Brook, Glen House & Pinkham Notch Camp; Warren; Woodstock. NEW YORK—West of Keene, Adirondack Park. VIRGINIA—Lydia.

Lepidostoma ontario Ross

1941. *Lepidostoma ontario* Ross, Am. Ent. Soc. Trans. 67: 119. ♂, ♀.

The spermatheca of the female, fig. 23B, is roughly trianguloid in shape, but varies considerably in details of shape and proportions.

Records are available only for Ontario and New Hampshire, as follows: NEW HAMPSHIRE—Benton, Witcherville Brook; Mount Washington, Cog Railway, Gibbs Brook; Randolph; Woodstock, along Bog Brook and Pemigewasset River. ONTARIO—Algonquin Park, Costello Lake.

Unicolor Group

In this and the following group, the spermatheca is longer than wide, usually egg shaped and appears suspended from the end of the ventral bridge, figs. 24–26. In the *Unicolor* group the ninth tergite has only scattered hair, whereas in the *Vernalis* group this area has a

pair of definite setal patches. In the *Unicolor* group the females exhibit a wide variety of shapes of the ninth and tenth tergites and also of the spermatheca. Of the 14 species here included in this group, 7 have definitely associated males and females. All seven of these show excellent diagnostic differences and it is highly probable that, when identified, the females of many of the remaining 7 species will lend themselves to specific diagnosis.

The males of the group are characterized chiefly by the short claspers. The only notable exception to this is the species *jewetti*. The female of this latter species is not known so that its placement in this group must be considered tentative.

Lepidostoma unicolor (Banks)

1911. *Mormomyia unicolor* Banks, Am. Ent. Soc. Trans. 37: 357. ♂.

The wings of the male have an abundance of black scales mixed with the hair. The male genitalia, fig. 7A, have the lobes of the tenth tergite armed with a dorsal spine; and the postero-ventral region of each lobe is divided by a deep cleft into two sharp lobes. The clasper has the basal process stout and angled or curved forward over the body of the clasper and the dorsal process appears to branch from it; the apex is produced into a broad pad which appears somewhat button-like from lateral view.

The female has the simple type of head structures and wings typical for the genus. The ninth tergite, fig. 27A, is broad, without deep impressions, the tenth tergite is only slightly incised on meson and forms a broad semimembranous plate; the membrane forming the under side of the tenth tergite bears a sclerotized mesal thickening which ends in a round sclerotized area. The spermatheca is very similar to that illustrated in fig. 24B.

The type of clasper found in this species is characteristic of four species, which form a fairly definite complex: ***unicolor***, ***frosti***, ***strophis***, and ***knulli***.

Unicolor is widely distributed through the Rocky Mountain region. Apparently it also extends eastward through the northern part of the continent as indicated by records from Saskatchewan and Minnesota. Specimens have been examined from the following localities: BRITISH COLUMBIA—Vancouver. CALIFORNIA—Inyo County; Mono County, Convict Creek, Roads End; San Gabriel Mountains, Switzer's Camp. COLORADO—Buena Vista, Cottonwood Creek; Colorado Springs, Seven Falls Creek; Green Mountain Falls, Crystal Creek; Rocky Mountain National Park. IDAHO—Pope, Trestle Creek. MINNESOTA—Duluth. SASKATCHEWAN—Reindeer Lake. UTAH—Blacksmith Fork Canyon; Greenvine; Kamas; Logan; Lake Point; Whiterocks. WYOMING—Yellowstone National Park, Lewis River.

Lepidostoma frosti (Milne)

1936. *Atomyia frosti* Milne, Studies N. A. Tric. 3: 119. ♂, ♀.

The tenth tergite of the male, fig. 8A, is produced into a slender finger-like process projecting above a very angular ventral portion;

each lobe has a definite sclerotized spur on its dorsal margin. The clasper, fig. 8B, has the basal and dorsal processes forming a distinct Y from lateral view. I have no large collections of this species available and hence have been unable to associate with certainty the female and male.

Present records of the species are restricted to the northeastern area, with records for Pinkham and White Mountains, New Hampshire, and Knowlton, Quebec.

Lepidostoma strophis Ross

1938. *Lepidostoma strophis* Ross, Ill. Nat. Hist. Surv. Bull. 21: 177. ♂.

The female of this species has the ninth and tenth tergites similar in most respects to *quercina*, illustrated in fig. 29A and C. In *strophis* the spermatheca is distinctive; the ventral bridge flares out considerably beyond the sides of the spermatheca and is situated so that it lies at the top of or above the spermatheca, fig. 24B.

The species is transcontinental in distribution with records scattered from Maine to the Pacific coast. The following records are available: BRITISH COLUMBIA—Cultus Lake; N. of Ft. St. James, Middle River at Takla Lake; Vernon (1 ♂ paratype of *roafi*, INHS). CALIFORNIA—Mono County, Hot Creek. COLORADO—Gould. MAINE—Double Top Mountain, Sourdnahunk River. MICHIGAN—Montmorency County, Hunt Creek; Beulah. MONTANA—Hamilton. OREGON—Corvallis, Dixon Creek; Foster, Santiam River; Klamath Lake, Barkley Springs; Tidewater. UTAH—Providence.

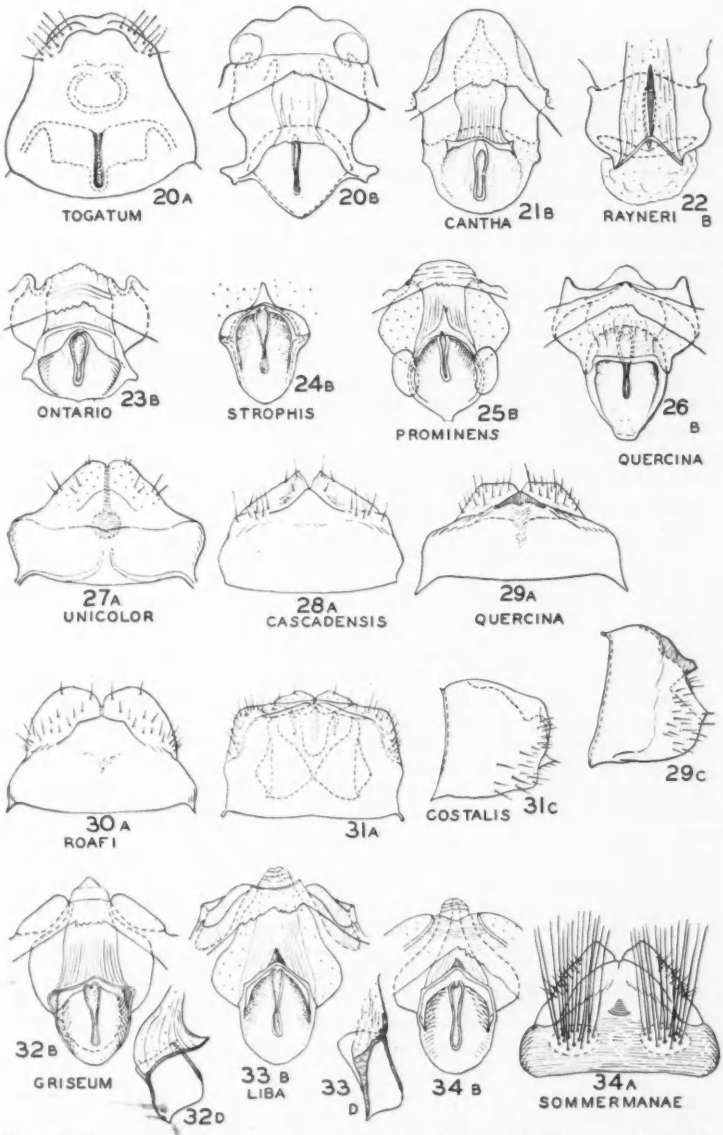
Lepidostoma knulli n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Body color medium brown with the venter of the abdomen, legs, and palpi lighter. Wings light brown, the wings with hair but without patches of scales. Basal segment of antenna subequal in length to greatest length of eye. Maxillary palpi short and spatulate, usually held together to form a mask in front of the face. Wings without scale pockets or peculiarities of venation.

Genitalia as in fig. 10. Ninth segment short and almost annular. Tenth tergite forming two widely separated lobes, each studded with small protuberances, with a seta arising at the base of each; the arms proceed slightly laterad, but the tips recurve slightly mesad. Claspers with basal process long and stout, curving posterad above the clasper and subequal in length to the body of the clasper; the dorsal process is short and appears to arise from the base of the basal process; the tip of the clasper is divided into two thick wide lobes, of which the dorsal one is rounded and the ventral one truncate from ventral view, fig. 10B.

Holotype, male.—Oak Creek Canyon, Arizona, Aug. 15, 1938, D. J. & J. N. Knull.

This species is most closely related to *strophis*, differing in the shape of the lobes of the tenth tergite and the shorter dorsal process of the claspers.



Figs. 20–34. *Lepidostoma*, female genitalia: A, ninth and tenth tergites, dorsal aspect; B, spermatheca and subgenital plate, ventral aspect; C, ninth and tenth tergites, lateral aspect; D, spermatheca, lateral aspect.

Lepidostoma podager (MacLachlan)

1871. *Nosopus podager* McLachlan, Linn. Soc. London Jour. 11: 116. ♂.

The genitalia of this species are almost exactly as illustrated for *quercina* (Ross 1938*a*: p. 176). In *podager* the tibia and basitarsus of the front legs, fig. 11D, and the maxillary palpi are greatly expanded and leaf-like, covered by a dense brush of scales. I have seen no females of this species, but Milne (1936) indicates that it is of the usual simple *Lepidostoma* type and superficially very similar to *roafi*. It is probable that a detailed study of this female will indicate close similarities to the figures here given for *quercina*. The species was originally described from California and has been recorded since from no other state. I have seen only paratypes of MacLachlan's species and a series from San Geronimo, both in the collection of the Museum of Comparative Zoology.

The pointed apex of the claspers (as in figs. 12, 13) of this species is typical of a fairly large complex including *podager*, *quercina*, *cascadense*, *roafi*, *bryanti*, *prominens*, *delongi*, and the two species formerly considered in *Olemira*, namely, *americanum* and *costalis*.

Lepidostoma quercina Ross

1938. *Lepidostoma quercina* Ross, Ill. Nat. Hist. Surv. Bull. 21: 176. ♂.

As pointed out in the original description, the male genitalia of this species are practically identical with those of *podager*. The legs and mouthparts, however, are slender and quite normal. The species was originally described from a single male. Subsequent collections very kindly sent to me by the staff of Oregon Agricultural College, Corvallis, Oregon, have contained considerable additional material of this species, including associated males and females. In all these the legs and palpi are simple in structure, showing no tendency to the enlargement of these parts which is characteristic of *podager*. The female is relatively stout bodied, compared to other members of the genus. Its ninth and tenth tergites, fig. 29A and C, are short; the ninth tergite forms a darkened angulation at the apex, the tenth tergite forms a pair of wide, well separated lobes which are truncate at the apex. The spermatheca, fig. 26B, is ovoid, tapering at its free end; the ventral bridge is well marked and situated so that it crosses the spermatheca considerably lower than in most of the other species.

To date records are available only from Oregon, as follows: Benton County, Rock Creek and north fork of Alsea River; Clatsop County, Big Creek; Corvallis, Oak Creek; Philomath, Woods Creek; Silver Creek Falls.

Lepidostoma cascadense (Milne)

1936. *Jenortha cascadensis* Milne, Studies N. A. Trich. 3: 119. ♂.
1938. *Lepidostoma pleca* Ross, Ill. Nat. Hist. Surv. Bull. 21: 175.

In this species the antennal scape has a strong lateral process and the basal tenth of the costal cell is reflexed to form a conspicuous scale filled pocket. These peculiarities form the basis of the genus *Jenortha* Milne, of which the species is the genotype. The male genitalia have been illustrated by Ross (1938*a*: p. 176) in the original description of

the synonym *Lepidostoma pleca*. Female spermatheca is very similar to that of *strophis* (fig. 24), but the sides of the ventral bridge are not flared out as in that species. The ninth and tenth tergites of *cascadense*, fig. 28, are diagnostic for the species, the ninth tergite forming a moderately sharp apex, the tenth tergite divided into well marked submembranous lobes which taper to a pointed apex separated by a V-shaped fissure.

The two previous descriptions involving this species were based on records from British Columbia and Washington. Since then additional material has shown that the species is widely distributed throughout the entire Rocky Mountain area. It has been taken along a wide variety of streams but all of them are cold and rapid, most of them of the true mountain cascades. Records are available for the following localities: BRITISH COLUMBIA—Vancouver, Mosquito Creek, Capilano River; Whonnock, Whonnock Creek. CALIFORNIA—Tuolumne County, Yosemite National Park, Tuolumne River. COLORADO—Buena Vista, Collegiate Peaks; Cascade Lodge; Estes Park; Green Mountain Falls, Crystal Creek; Rocky Mountain National Park, Thompson River. IDAHO—Pope, Trestle Creek. MONTANA—Dutch Creek; Sprague County; Roe's Creek; Trick Falls Creek; all in Glacier National Park. WASHINGTON—Suitan, Anderson Creek.

Lepidostoma delongi n. sp.

Male.—Length from front of head to tip of wing, 9 mm. Color dark brown, the legs and palpi slightly lighter. Wings uniformly stained with light brown. General structure typical for genus. Maxillary palpi with only indistinct segments, and forming a brush which is longer than the scape, densely clothed with long scales and somewhat plume-like in general appearance. Antennal scape as long as width of head, slender and cylindrical, with only a shallow ventral groove filled with scales. Front wings with neither scale pockets nor other unusual features.

Male genitalia, fig. 12, with ninth segment nearly annulate, separated from tenth by fairly distinct furrows. Tenth tergite divided into a pair of deep lobes, each with a few sclerotized teeth on the dorsal side of the apical portion, and with a scattering of setae over the dorsal region. Claspers, fig. 12B, short, the base having a fairly long basal process and a longer tapering dorsal process; apex of clasper with ventral lobe tapering to a sharp point, dorsal lobe rounded.

Holotype, male.—Zitacuara, Mexico, at light, 1941, D. M. DeLong.

On the basis of genitalia, this species most closely resembles *cascadense* but differs from it in the deep and plate-like lateral aspect of the lobes of the tenth tergite. It differs also in the simple antennal scape.

Lepidostoma prominens (Banks)

1930. *Arcadopsyche prominens* Banks, Brook. Ent. Soc. Bull. 25: 129. ♂.

This species is readily distinguished in the male by the two long spur-like ventral processes of the tenth tergite (Ross 1938*c*: fig. 91). This latter drawing was made from a paratype male kindly made available to me by Mr. Nathan Banks, Museum of Comparative Zoology. The female is readily distinguished by the spermatheca,

which bears on each side a ventral ear-like expansion which appears to be attached at the juncture of the ventral bridge and spermatheca, fig. 25.

The species was described from Cape North, Cape Breton, Nova Scotia. Another record is available from Grand Lac Jacques Cartier, Laurentian National Park, Quebec.

Lepidostoma bryanti (Banks)

1908. *Alepomyia bryanti* Banks, Psyche 15: 65. ♂.
1909. *Lepidostoma wisconsinensis* Vorhies, Wisc. Acad. Sci. Arts & Letters Trans. 16: 685. ♂.

The male of this species has been well illustrated by Banks and Vorhies in the original descriptions cited above and also by Betten (1934: pl. 62, figs. 10, 11; pl. 63, fig. 1). I have no females positively associated with the males of this species. Only a few records are available for this species but they are scattered over a wide area of the northern and eastern states, as follows: NEWFOUNDLAND—Grand Lake. NEW YORK—Old Forge. PENNSYLVANIA—Monroe County. WISCONSIN—Devil's Lake and Parfrey's Glen (near Madison).

Lepidostoma roafi (Milne)

1936. *Atomyia roafi* Milne, Studies N. A. Tric. 3: 120. ♂, ♀.

The male of this species is distinguished from all its allies by the shape of the lobes of tenth tergite and claspers, fig. 13. The clasper has only a short basal process which just barely extends to the dorsal level of the clasper; the dorsal process is very long and extends to within a short distance of the pointed tip of the clasper. The female is readily distinguished by the combination of the spermatheca, which resembles very much that of *prominens* (see fig. 25) without the "ears," and the structure of the ninth and tenth tergites, fig. 30. The ninth tergite is of moderate length and produced into a slightly angulate area. The tenth tergite forms two large ovate semi-membranous lobes separated by a distinct notch on the meson.

The species is apparently widely distributed through the Rocky Mountain region, with definite records for the following: BRITISH COLUMBIA—Vancouver. CALIFORNIA—Convict Creek, Mono County. COLORADO—Buena Vista, Collegiate Peaks; Cameron Pass; Crystal Creek, Green Mountain Falls; Colorado Springs, Seven Falls Creek; Eagle County; Gothic; Pingree Park; Science Lodge, Boulder County. MONTANA—Elliston. WASHINGTON—Dewatto. WYOMING—Wilson, Coal Creek.

In the original description of the species, Milne lists Oregon as one of the paratype localities. In the paratype series, there is a mixture of both *roafi* and *strophis* and the only one of these that I have seen from Oregon is a specimen of *strophis*. Although the species undoubtedly occurs in Oregon, there seems no definite record of it as yet from that state.

Lepidostoma americanum (Banks)

1897. *Olemira americanum* Banks, Am. Ent. Soc. Trans. 24: 29. ♂, ♀.

The male characters have been well described by Betten (1934: pl. 64, figs. 1–5). In general structure this species is very similar to

the following, *costalis*, differing chiefly in the very long dorsal spur of the lobes of the tenth tergite, fig. 14. I have not examined females of this species. ***Mormonia pictilis*** Banks, described from a single female, has frequently been listed as a synonym of ***americanum***. Until distinguishing characters are worked out to identify to species more females in the genus, it seems better to list ***pictilis*** as an unplaced species.

Originally described from Sea Cliff, New York, it has since been reported by Banks from Manitoba and Virginia. Recently I have received a record of it from Neel Gap, Georgia.

Lepidostoma costalis (Banks)

1914. *Olemira costalis* Banks, Can. Ent. 46: 265. ♂.

The males of this species have been illustrated by Banks in the original description and by Betten (1934: pl. 63, fig. 4; pl. 64, figs. 1–5). A detail of the diagnostic characters of the tenth tergite is given in fig. 15. The female has a very massive development of the ninth tergite, fig. 31, which overlaps the small semi-membranous lobe of the tenth tergite. The spermatheca is similar in general to that of ***prominens***, fig. 25, but lacks the "ears."

This species has been recorded from various localities from the northeast, as follows: MAINE—Mt. Katahdin, Togue Pond; New Limerick, Hunter Brook. MICHIGAN—Montmorency County, Hunt Creek. NEW YORK—Ogdensburg; Fulton County. ONTARIO—Costello Lake, Algonquin Park.

Lepidostoma jewetti n. sp.

Male.—Length from front of head to tip of wing, 10 mm. Color brown, the venter and appendages lighter. Wings only slightly darkened. General structure typical for genus. Maxillary palpi short and finger-like, only half the length of the scape and clothed with loose brushy hair. Antennal scape cylindrical, about as long as the width of the head, its mesal side bearing a shaggy brush of scales and hair which extends the entire length of the scape. The front wings with basal fifth of costal cell reflexed and folded back over dorsum of wing to form a scale pocket; both front and hind wings with rows or patches of black scales along radial sector veins and cells posterior to it.

Male genitalia as in fig. 16. Ninth segment almost annular, separated from tenth tergite by a definite crease. Tenth tergite divided into a pair of fairly long lobes which are almost parallel, in dorsal view rounded at the tip, from lateral view somewhat snout-like with a distinct elevation near dorsum and a sharp incision on the ventral margin. Claspers of moderate length, with a fairly long finger-like basal lobe and a long slender mesal lobe which is appressed to, and nearly as long as, the body of the clasper. The apex of the clasper is not subdivided into definite folds but is quite thin, appearing wide and truncate from lateral view and almost linear from ventral view.

Holotype, male.—Ellsworth, Washington, May 15, 1941, S. Jewett, Jr.

The undivided apex of the clasper separates this species immediately from all other members of the *Unicolor* group, and other features of the

clasper distinguish it from all other Nearctic members of the genus. The species is sufficiently distinct that it could well form a subgroup or distinctive group of its own. The female is unknown; when discovered, its structure will undoubtedly assist in a more definite group placement of this species.

Vernalis Group

To this group belongs a heterogenus complex of species which are similar in many features to the *Unicolor* group but have patches of long setae developed on some of the apical tergites. Of these the species *griseum* is very similar to members of the *Unicolor* group, in particular the complex containing *roafi* and *bryanti*. It is undoubtedly a linking form between these two groups. Of the remaining species in the group, *vernalis* and *sackeni* are extremely distinctive, and *liba* and *sommermanae* together form a small but equally distinctive complex.

Lepidostoma griseum (Banks)

1911. *Phanopsyche griseum* Banks, Am. Ent. Soc. Trans. **37**: 357. ♂.

This species is similar to many members of the *Unicolor* group in structure of the claspers, but differs from them in the cushions of setae on the apical tergites. On the sixth, seventh, and eighth segments these setal cushions are only a little larger than those on the ninth tergite, fig. 17, but the hairs are longer and form erect brushes. Many features of the adult structure, including venation and the male genitalia, are illustrated by Betten (1934: pl. 64, figs. 6–12). Additional details of the male genitalia are given here in fig. 17. The female spermatheca, fig. 32, is surmounted by a ventral bridge which flares considerably ventrad of the spermatheca itself.

This species is distributed through several northern and eastern states and Ontario, as follows: MICHIGAN—Montmorency County, Hunt Creek. NEW JERSEY—Milltown. NEW YORK—McLean; Ogdensburg; Woodworth's Lake, Fulton County. ONTARIO—Algonquin Park, Costello Lake. PENNSYLVANIA—Columbia Cross-Roads. TENNESSEE—Gatlinburg.

Lepidostoma sommermanae n. sp.

Male.—Length from front of head to tip of wing, 8 mm. Color dark brown, the appendages and venter yellowish brown to tawny, scape of antennae short, subequal in length to mesal length of head, clothed with short scattered hair. Maxillary palpi finger-like, short, the inner surface bare, the outer surface clothed with a brush of dark hair. Legs and wings without special modifications, similar in most respects to those of the females.

General structure and proportions of genitalia as illustrated by Ross (1941*b*: fig. 97) for *liba*. Ninth segment annular, with a pair of large cushions of hair, one on each side of the meson. Tenth tergite divided into a pair of lateral sclerotized arms and a mesal pair of inconspicuous membranous lobes. Clasper, fig. 18, with lateral aspect irregular, tapering to a point, with the dorsal process slender and pointed, curving mesad into an irregular process bearing several stout spines; this spined area appears as a flange-like projection from caudal view.

Female similar in size and general color to male. Ninth tergite large, produced into a long dorsal portion and with a pair of hair cushions on either side of the meson near base, fig. 34A. Tenth tergite forming two more or less triangular lobes separated on the meson by a wide fissure. Spermatheca, fig. 34B, ovate, with a definite ventral bridge which in profile does not project ventrad of the profile of the spermatheca. Subgenital plate with mesal portion definitely sclerotized, lateral area membranous.

Holotype, male—Mt. Carmel, Connecticut, Woodruff's Pond, May 15, 1944, Mrs. A. H. Sommerman.

Allotype, female.—Mt. Carmel, Connecticut, September 4, 1944, Mrs. A. H. Sommerman.

Paratypes.—CONNECTICUT—Mt. Carmel, Spruce Bank Spring, June 26, 1944, Mrs. A. H. Sommerman, 1 ♂; Sept. 4, 1944, 1 ♀. PENNSYLVANIA—Roxboro, June 28, 1♂; Aug. 15, 1909, Haimbach, 1 ♂ (ANSP).

This species was collected as larvae and subsequently reared by Mrs. Sommerman in a small springfed brooklet at Mt. Carmel. The cases which she obtained were all of the round stone type and the observations on their habits correspond closely with those observed for *liba*. Betten illustrated the clasper of this species (1934: p. 401, pl. 62, figs. 8, 9) under the name *Mormomyia vernalis*. Dr. Betten very kindly loaned me the preparation of his material to aid in verifying its identity.

The species is a close relative of *liba*, differing chiefly in the subgenital plate of the female and the basal process of the male clasper.

Lepidostoma liba Ross

1941. *Lepidostoma liba* Ross, Am. Ent. Soc. Trans. 67: 120. ♂, ♀.

Since the original description, the larva and habitat preference of this species has been discussed by Ross (1944: p. 259). The species has not yet been recorded outside of Illinois where it occurs in a few isolated springfed streams. In the original description the illustration of the spermatheca lacks much detail and a revised drawing is presented in fig. 33.

Lepidostoma vernalis (Banks)

1897. *Mormonia vernalis* Banks, Am. Ent. Soc. Trans. 24: 29. ♂, ♀.

The male genitalia of this species have been illustrated by Ross (1938*c*: p. 90), from a paratype. The species is one of the most striking in the genus. I have seen no females of this species or *sackeni*.

The species was described from Sea Cliff, New York, and later recorded by Banks from Tyron, North Carolina. Dr. Betten has loaned me an additional male from McLean, New York.

The illustrations given by Betten under the name *Mormomyia vernalis* (1934: p. 401, pl. 62, figs. 8, 9), represents *sommermanae*.

Lepidostoma sackeni (Banks)

1936. *Mormomyia sackeni* Banks, Arb. Morph. Tax. Ent. aus Berlin-Dahlem 3: 267. ♂.

To the illustrations given by Banks in the original description, I am adding illustrations of a few details of the male genitalia, fig. 19. These

drawings are made from a paratype kindly loaned to me from the Museum of Comparative Zoology by Mr. Banks. As pointed out by Banks, the extremely bulbous ninth tergite distinguishes this species immediately from all others in the genus. The lateral lobes of the tenth tergite are sclerotized biramous structures and situated in the middle of the lateral aspect of the segment, fig. 19A.

Lepidostoma (species of uncertain status)

The following species of *Lepidostoma* are known only from females. I have not examined their genitalia so that it is impossible at the present time to be certain of their placement.

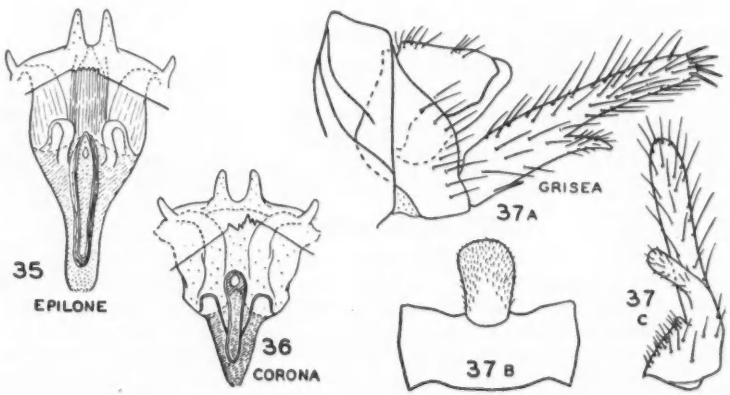
Silo cinereum Banks, 1899, Am. Ent. Soc. Trans. 25: 210. Described from California.

Thremma deceptiva Banks, 1907, Wash. Ent. Soc. Proc. 8: 125. Described from New Mexico.

Lepidostoma stigma Banks, 1907, Wash. Ent. Soc. Proc. 8: 125. Described from Colorado.

Olemira mexicana Banks, 1901, Am. Ent. Soc. Trans. 27: 367. Described from Mexico.

Mormonia pictilis Banks, 1899, Am. Ent. Soc. Trans. 25: 211. Described from Franconia, New Hampshire. This species has sometimes been listed as a synonym of *americanum*.



Figs. 35–36. *Theliopsyche*, female spermatheca and subgenital plate, ventral aspect.
Fig. 37. *Theliopsyche*, male genitalia: A, lateral aspect; B, eighth sternite; C, left clasper, ventral aspect.

Genus **Theliopsyche** Banks

In addition to characters of the warts on the head, this genus is readily distinguished from *Lepidostoma* by the broad mesal plate-like process of the eighth sternite of the males, fig. 37B, and by the elongate,

triangular spermatheca of the female. The female has been associated with only two of the four species but in each case, figs. 35, 36, the ventral elliptic ridge is much wider and larger than in species of *Lepidostoma*, in which it is very narrow.

The genus *Quisilo* Milne (genotype *Silo griseus* Hagen) and the subgenus *Aopsyche* Ross (genotype *Theliopsyche corona* Ross), are based primarily on secondary sexual characters of the male and I am doubtful if these represent significant phylogenetic divisions of the genus. Until additional material is available for study, it seems best to consider the genus *Theliopsyche* as an undivided unit.

KEY TO SPECIES

1. Maxillary palpi 3-segmented (males) 2
   Maxillary palpi 5-segmented (females) 5
2. Claspers elongate, with no dorsal lobe, but with a curved, sub-basal, finger-like lobe, fig. 37 ..... **grisea**
   Claspers shorter, with a dorsal lobe (Ross 1938*a*: fig. 115) 3
3. Ventro-mesal lobe of claspers long and truncate (Ross 1938*a*: fig. 115) ... **epilone**
   Ventro-mesal lobe of claspers very short, either wide and truncate or hooked .. 4
4. Ventro-mesal lobe of claspers wide and truncate, front wing with very wide sub-costal cell, with branches of Radius crowded together (Ross 1938*a*: fig. 116) ..... **corona**
   Ventro-mesal lobe of claspers narrower, pointed and hooked (Ross 1944: fig. 885); venation without displacement of veins (Betten 1934: pl. 63, fig. 3), **parva**
5. Spermatheca moderately short, fig. 36 ..... **corona**
   Spermatheca very long, its free end lengthened into a long, subparallel tongue, fig. 35 ..... **epilone**

Theliopsyche parva Banks

1911. *Theliopsyche parva* Banks, Am. Ent. Soc. Trans. 37: 356. ♂, ♀.

The species was described from Woodworth's Lake, Fulton County, New York, and no additional records are available. The species is readily distinguished by the ventral aspect of the claspers and the small mesal process of the eighth sternite. In 1937 I cleared the genitalia of the type and drawings made from this preparation have been published previously (Ross: 1944, fig. 885).

Theliopsyche corona Ross

1938. *Theliopsyche corona* Ross, Ill. Nat. Hist. Surv. Bull. 21: 174. ♂.

Originally described from Gatlinburg, Tennessee, the species has since been taken from Andrews Bald, Great Smoky Mountain National Park, North Carolina. This latter collection contains associated males and females.

The wings and maxillary palpi of the male illustrated in the original description are very striking, but the genitalia indicate a very close kinship with *parva*. In the female the wings are of the unmodified type and the spermatheca, fig. 36, is trianguloid and the elliptic ridge is wide, long and appears to project beyond the posterior margin of the spermatheca. The subgenital plate has two pairs of membranous horn-like processes, a mesal pair and a lateral pair.

Theliopsyche epilone Ross

1938. *Theliopsyche epilone* Ross, Ill. Nat. Hist. Surv. Bull. 21: 173. ♂.

The species was described from Newfound Gap, Great Smoky Mountains, North Carolina. Since then I have received a collection of associated males and females from the Smoky Mountains but on the Tennessee side. The female is identical in color and general structure with that of *corona*, differing chiefly in the elongate and tapered spermatheca, fig. 35.

Theliopsyche grisea (Hagen)

1861. *Silo griseus* Hagen, Syn. Neur. N. A.: 273. ♂.

Of this species I have seen only the unique male type from Trenton Falls, New Jersey. It is characterized by the very large mesal flap of the eighth sternite and the long clasper of the male, fig. 37. These illustrations are drawn from the preparation of the type. My notes are not complete on the structure of the tenth tergite and aedeagus but it is hoped that the details of the claspers will be of assistance in identifying the species.

GENERA NOT STUDIED

Genus *Atomyoides* Ulmer.—This genus was erected by Ulmer (1911: p. 25, figs. 10–13) for the species ***bispinosa*** Ulmer from Costa Rica. I have not had an opportunity to study this species. The genitalia are figured in detail by Ulmer and it is entirely different from any species recorded north of that area. It may eventually prove to belong to the genus *Lepidostoma* but the species does not fit well into any of the groups outlined for *Lepidostoma* in this paper and it seems better to consider the genus separate, at least for the time being. No female has been described for the species. I have not included this genus in the key because of lack of information regarding its structure. Betten (1934) suggests that it is a close relative of species which I am placing in the *Unicolor* group.

Genus *Eremopsyche* Banks.—At the present time I am unable to add to the information contained in the original description of this genus, which was erected by Banks (1901: p. 367, figs. 13, 14) for the Mexican species *frontalis* Banks. Banks' illustrations indicate that the genus is a close relative of *Lepidostoma*, and it is entirely possible that *frontalis* may be a close relative of some of the species at present placed in *Lepidostoma*.

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Ulmer, Georg. 1911. Einige Südamerikanische Trichopteren. Ann. Soc. Ent. Belg., 55: 15–26, 13 figs.

[1]For purposes of continuity, the letter designations are the same as those listed in Ross 1944.

LOS ANOFELINOS DE LA REPUBLICA DEL ECUADOR, by ROBERTO LEVI CASTILLO. 172 pages + 10 folded plates + 30 pages of photographs. Artes Graficas Senefelder C. A. Ltda., Guayaguil, Ecuador, 1945.

Morphological descriptions are given of all available stages of ten species of anophelines, one of which, *pseudopunctipennis* Theobald, is represented by two varieties, *levicastilloi* Levi Castillo 1944, and *rivadeneirai* Levi Castillo 1945. There is much information on ecology, geographic distribution, and significance in malaria transmission. Keys have been devised to separate eggs, larvae, females, and male terminalia. The ten folded plates are printed on both sides; fifteen are on anatomy and five on geographic distribution. Numerous photographs show mainly the breeding places of larvae and methods of collecting. There is a bibliography of over one hundred references and an index. The binding is paper and this volume is the first of a proposed series.—CARL E. VENARD.

ON SOME DIPLOPODS FROM THE INDO-AUSTRALIAN ARCHIPELAGO, by RALPH V. CHAMBERLIN. American Museum Novitates, Number 1282, 43 pages, 136 figures. 1945.

This publication is not revisional in nature but is made up of descriptions of new genera and species with a few notes on others already established and a key to the species of one genus, *Papuosoma*. Since sixty-four new species and fourteen new genera are described, it will be important to specialists in the group. The figures of anatomical details are well drawn and well printed.—A. W. L.

THE FEMALE GENITALIA OF THE WYEOMYIA OF NORTH AMERICA
(Diptera: Culicidae)

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The difficulty in separating the females of our three species of *Wyeomyia* is well known to taxonomists who have studied this genus. Matheson (1944) points out the fact that the female of *W. vanduzeei* Dyar and Knab is very similar to *W. smithii* (Coquillett) the only diagnostic difference being the presence of white scales on the bases of the segments of the hind tarsi of *vanduzeei*. Matheson further states that the adults of *W. mitchellii* (Theobald) and *W. vanduzeei* are practically identical and that these two species can be distinguished with certainty only in the larval stage and by male genitalia. The larval and male genitalia characters are diagnostic for all three species of *Wyeomyia*.

There has been some controversy as to the value of female genitalia in the taxonomy of mosquitoes. Gerry (1932) in his review of the literature, finds fault with the methods of those workers who did not find specific characters of value because they ". . . failed to distend the abdomen sufficiently to separate the individual characters." After a study of nineteen species of Cuban mosquitoes, representing eight different genera, Gerry concluded that each generic group possesses diagnostic characters which can be used in the formation of a generic classification, and "In addition several promising specific characters have been observed, some of which are not manifest but may be made visible with the aid of a microscope." Gjullin (1937) studying the female genitalia of *Aedes* of the Pacific coast found that morphological characters are present which may be used to separate some of the species. However, the species having similar or identical coloration also have nearly identical genitalia and therefore he concludes that female genitalia in this group have only limited taxonomic value.

The present paper will show that our three species of *Wyeomyia* can be separated by female genitalia characters. The terminology (figs. 3–5) used in the present description is that of Edwards (1941) which in large part is based on the earlier works of Macfie and Ingram (1922), Christophers (1923), Gerry (1932) and Gjullin (1937). Specimens were cleared in KOH and mounted in chloral gum medium. Some of the adults studied were reared from known larvae. Locality data for the specimens examined are as follows: *W. smithii*—North Carolina (Wilmington), *W. vanduzeei*—Florida (Avon Park and Boca Raton), *W. mitchellii*—Florida (Avon Park, Boca Raton, and New Smyrna). The drawings were made with the aid of an ocular grid. Slides of the genitalia have been deposited in the Ohio State University Museum. The writer wishes to thank Roy W. Chamberlain for his aid with some of the drawings, and Dr. Carl E. Venard for critically reading the manuscript.

In the genus *Wyeomyia* (figs. 1–5), the cerci are reduced in length, somewhat compressed and truncate or nearly so apically. The postgenital plate is about the same length or longer than the cerci, truncate or rounded apically and basally appears narrow due to a concentration of pigment. These pigmented areas are best seen when the individual structures are dissected and mounted separately thus eliminating the interference of underlying parts which are plainly seen in a cleared specimen. Actually the lateral margins of the postgenital plate expand basally and fuse with the cowl and membranous anal segment. The postgenital plate comprises two portions, the proximal part, probably representing the tenth sternite and the distal part the eleventh sternite or postgenital plate proper. The cowl is well pigmented, band-like and separated from the postgenital plate by a membrane. Edwards restricts the cowl to the sclerotized posterior rim of the atrium whereas Macfie and Ingram speak of the sigma and cowl together as the ninth sternite and Gerry and Gjullin call the cowl the ninth sternite. The cowl bends anterodorsally and fuses with the sigma which doubles back posteroventrally. The insula is a small chitinous plate which lies in the midventral line closely associated with the sigma. In some genera this plate may be distinctly separated from the sigma by a membrane, or it may be fused to the sigma though still distinguishable from it by a difference in the pigmentation of the two structures. Christophers pointed out the fact that the "insula may be blended with the sigma." In the genus *Wyeomyia* the apron-like medial expansion of the sigma apparently represents the insula plate which has become so completely fused with the sigma that no line of demarkation between the two structures is visible. Insula setae are present. Edwards believes that the insula plate represents the vestigial ninth sternite. Atrial plates are absent. The ninth tergite is spicular and band-like with or without large setae. When present these setae vary frequently in number and arrangement. The tenth tergites are spicular, may or may not be wrinkled, and have indefinite outlines (in figures 4 and 5 the tenth tergites have been drawn more darkly outlined than they normally are). The tenth tergites articulate with the cerci and ninth tergite by means of a thin connecting membrane. Three round darkly pigmented spermathecae each with a small nipple-like projection are present. These sclerotized projections are the beginning of the spermathecal ducts.

KEY TO THE FEMALE GENITALIA OF WYEOMYIA

1. Postgenital plate distinctly rounded apically; insula plate broad, the sides almost parallel with rounded corners and a straight or slightly indented anterior margin (fig. 1) ..... **smithii**
   Postgenital plate more or less truncate apically with slightly rounded corners; sides of insula plate parallel or gradually tapering to a rounded or indented anterior margin 2
2. Basal region of the postgenital plate with numerous round pores most of which bear minute setae; postgenital plate longer than cerci; anterior edge of insula plate round, not indented, with lateral and anterior margins pigmented, and with a round more lightly pigmented or colorless central area (fig. 3) ..... **mitchellii**
   Basal region of the postgenital plate without round pores but with long slender setae extending up the entire ventral surface; anterior margin of the insula plate slightly or distinctly concave; lateral regions darkly pigmented and separated by a light medial strip (fig. 2) ..... **vanduzeei**

Description of the Female Genitalia

Wyeomyia (Phyllozomyia) smithii (Coquillett)

(Figure 1)

Cerci—Short, roughly quadrangular, the corners rounded, anterior margin only slightly or not at all convex; inner and outer surfaces spicular with large setae restricted to about the apical half. *Postgenital Plate*—About as long as or longer than the cerci; apex rounded, both dorsal and ventral surfaces densely spicular; ventrally, large setae restricted to the apical half and a few setae irregularly dispersed below the middle; basally the pigment pattern forms a rounded area in which are found a dense grouping of minute spicules and rarely an occasional round pore from which may arise a fine seta; dorsal surface with numerous stout apical and subapical setae irregularly arranged and an occasional seta occurring below the middle of the plate. *Cowl*—A sclerotized band with slightly wavy margins and separated from the postgenital plate by a very light membrane; spicular, the spicules dense on the medial region, decreasing in number laterally so that the band at the point of junction with the sigma is almost completely bare. *Sigma and Insula Plate*—Sigma a lightly pigmented spicular membrane with a roundly indented posterior margin, extending ventrally to broaden into the apron-like insula plate; plate roughly quadrangular, its lateral margins parallel or indented posteriorly (near the anterior margin of the sigma); corners rounded, the anterior medial margin little or not at all indented; anterolateral corners of the plate more darkly pigmented and separated by a lightly pigmented region; plate covered with minute spicules and with a group of about seven to ten long slender setae arising from each darkly pigmented corner. *Ninth Tergite*—A broad finely spicular band whose anterior margin is nearly straight and posterior margin medially indented; with or without long setae; when setae are present their number and arrangement may vary as follows: one on

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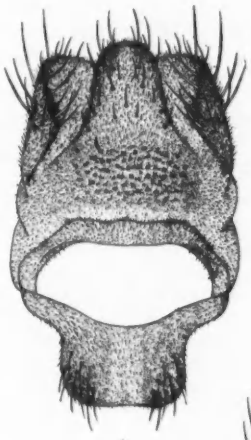
EXPLANATION OF PLATE I

Fig. 1. Ventral view of *W. smithii*. Fig. 2. Ventral view of *W. vanduzeei* (Tenth tergite lies dorsally behind the cerci and is not shown in the drawing). Fig. 3. Ventral view of *W. mitchellii*. Fig. 4. Lateral view of *W. mitchellii*. Fig. 5. Dorsal view of *W. mitchellii*.

ABBREVIATIONS

A—atrium
AS—anal segment
C—cowl
CS—cercus
I—insula
N—ninth tergite
P—postgenital plate
S—sigma
T—tenth tergite

(In figures 1–3 the sigma has been pulled down so that the atrial cavity is shown much larger than normal; actually the cowl and sigma are folded together leaving a comparatively small opening to the chamber. Figure 4 shows the sigma partly folded towards the cowl. When the eighth segment is not dissected away and the genitalia is not under pressure of a cover glass, the sigma lies somewhat closer to the cowl and the insula points more posteriorly than that shown in figure 4. In figures 1 and 3 the cowl is also extended, exposing part of the membrane which joins it to the postgenital plate. Figure 2 shows the cowl in a more normal position.)



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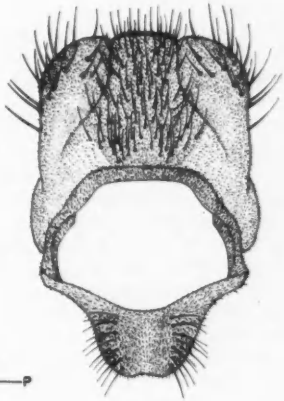

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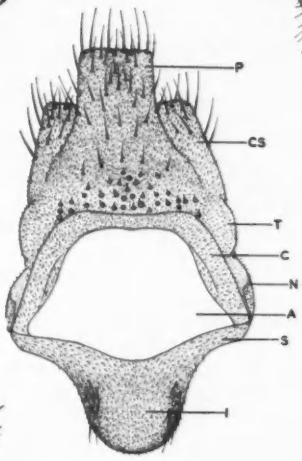

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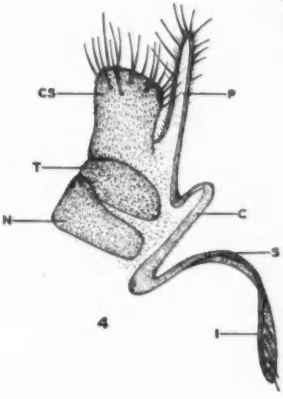

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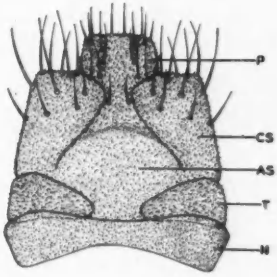

5

each side of the posterior median margin or two on one side and one on the other, or two on one side and none on the other. *Tenth Tergite*—Large, the margins somewhat irregular and weakly defined; wrinkled and covered with fine spicules (finer than those on the cerci) arranged in definite groups, the spicular pattern different from that on the cerci.

Wyeomyia (Phyllozomyia) vanduzeei Dyar and Knab[1]

(Figure 2)

Cerci—Short, almost truncate with rounded apical corners; distal half expanded and broader than the basal region; all surfaces spicular except for a small basal region on the inner surface; large setae restricted to the apical half of the outer and inner surfaces and an occasional seta occurring on the basal half. *Postgenital Plate*—About as long as or a little longer than the cerci, apex somewhat truncate or only a little rounded; ventral basal half (tenth sternite) rounded off by a dense grouping of fine spicules; long slender hair-like setae more or less regularly arranged within this finely spicular and more darkly pigmented area, and extending up the entire surface of the plate; dorsal subapical and apical surface with about twelve short stout setae; both surfaces of the plate spicular. *Cowl*—A spicular sclerotic band with the spicules extending laterally to the junction with the sigma. *Sigma and Insula Plate*—Sigma a narrow, lightly pigmented spicular band with an indented posterior margin and which extends ventrally and broadens into the median insula plate; sides of insula taper toward the middle to form a rounded, slightly or distinctly concave anterior margin; outer regions of plate darkly pigmented the two halves separated by a more lightly pigmented medial strip; entire plate spicular the medial spicules smaller than the outer ones; a group of about eleven or more long slender setae originate within the pigmented outer areas. *Ninth Tergite*—A fairly broad lightly pigmented spicular band whose anterior margin is deeply concave medially and posterior margin is almost straight; a variable number of large setae may occur on the posterior margin in the following combinations: a single seta on either side laterad of the middle; one or two large setae on one side only; or with three setae on one side and two on the other; or with three setae arranged medially all about equidistant, with one of the setae larger than the other two. *Tenth Tergite*—Small, roughly triangular, lightly pigmented and indefinitely outlined; not wrinkled, but with a spicular pattern slightly different from that on the cerci.

Wyeomyia (Wyeomyia) mitchellii (Theobald)

(Figures 3–5)

Cerci—Short, truncate with rounded apical corners; apical half

[1]The genitalia of this species has been described by Gerry (1932). However his description (and diagram) differ somewhat from the present one and seems to fit the characters of *mitchellii* (particularly the postgenital plate) more readily than *vanduzeei*. It is possible that the Cuban *vanduzeei* differs from our own or Gerry has actually described *mitchellii* as *vanduzeei*. Unfortunately Gerry does not give a detailed description of the basal half of the postgenital plate; had he done so there would be no question as to the species he has described. Both species are found in Cuba (Dyar, 1928).

broader than basal region; outer surface completely spicular, inner surface spicular only on apical half; large setae of various lengths restricted to the apical half of inner and outer surfaces. *Postgenital Plate*—About one third longer than the cerci; apex truncate with slightly rounded corners; basal region with a V-formed area marked off by slightly darker pigmentation (sometimes difficult to see); some slender setae found distributed over the ventral surface, but more numerous on the apical half (eleventh sternite); basal region of the plate (tenth sternite) with many large round pores from most of which may arise small setae; the pores extend below and laterally on either side of the V-shaped area (these structures appear very much like sense organs which have been described in the literature in other insects); stout apical and subapical setae are found on the dorsal surface; both surfaces of the plate spicular. *Cowl*—A sclerotized spicular band slightly concave on the posterior medial margin; spicules sparse near the junction with the sigma. *Sigma and Insula Plate*—Sigma a narrow spicular band which broadens anteriorly into the insula plate whose lateral margins may be more or less parallel or taper to a round convex anterior margin; lateral and anterior margins of plate more deeply pigmented than the central concave area; groups of nine to twelve setae are found within the darkly pigmented outer marginal regions; entire surface spicular, the spicules within the central lighter area smaller than the others. *Ninth Tergite*—A sclerotic band covered with minute spicules; posterior margin straight or slightly concave, anterior margin deeply concave; no large setae were noted. *Tenth Tergite*—Lightly pigmented with indefinite margins, wrinkled, finely spicular (finer than those on the cerci) the pattern different from that on the cerci.

CONCLUSIONS

The female genitalia of our three species of *Wyeomyia* have distinct diagnostic characters which are sufficiently constant to be of taxonomic value. The cerci and postgenital plate of *W. smithii* are much darker than the same structures of *vanduzeei* and *mitchellii*. Particularly the shape and chaetotaxy of the postgenital and insula plates show decided differences. Other minor variations are present and these are described for each species.

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CONNECTIVE TISSUE PATTERN IN THE VENTRICULUS OF CERTAIN LUBBER GRASSHOPPERS

(Orthoptera, acridiidae)

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Morehead, Kentucky

In the routine course of examining the tissues of the entire gut length of two selected grasshoppers the writer was impressed by the fact that the literature, especially generalized texts on insect anatomy and physiology, give practically no space to the important but somewhat obscure connective tissue of the midgut. Although loose connective tissue is sufficiently obvious in the large folds of pharynx, proventricular teeth, and of the fore-intestine, the author had to persuade himself by repeated examination of the midgut tissues of *Brachystola magna* (Gir.) and *Romalea microptera* (Beauv.) that connective tissue was definitely an essential constituent in the region here referred to. It became increasingly obvious that such tissue should be present both from genetic and adaptational considerations. Especially was the adaptional value evident when it was observed in a variety of preparations that the midgut is completely invested in loose connective tissue so reinforced as to constitute a probably firm "elastic" network covering the bases of epithelial masses and penetrating up between them. The unsupported epithelium soft and folded as it is in the midgut and its caeca, could scarcely be expected to endure the viscissitudes of the abrasive and stretching effects of a mass of such coarse vegetation as these insects ingest.

An examination of all available literature did in fact disclose some reference to a "peritoneum" and even to the more specific presence of loose connective tissue in the midgut of certain other grasshoppers and particularly in the case of the beetle *Dytiscus marginalis*, quoted by Snodgrass from Korschelt's two volume monograph. It is true that references are made to connective tissue, elsewhere than in grasshoppers by Schimmer (1909) in *gryllids*, Deegner (1910) in *Dysticus circumcinctus Ahr.*, Rungius (1911) in *Dytiscus marginalis* and the very recent and somewhat detailed treatment by Wermel (1938) with

EXPLANATION OF PLATE I

FIG. 1. Superficial view showing relations of longitudinal muscles (broad, wide bands), finely placed parallel circular muscles, and faint irregular polygons of connective tissue network. The irregular dark area is a residuum of epithelial tissue not yet eroded away. Unretouched photo.

FIG. 2. Semi-tangential section, superficial or basal view of enteric epithelial units surrounded nearest the body cavity (top of cut) by connective tissue—as a "carpet" (extreme top) and as a network (lower top) and eventually tapering off and disappearing (lowermost, where individual slightly separated cells are shown.)

FIG. 3. Cross-section at true right angles to the gut axis at a point near the Malpighian ampules (attachment of Malpighian tubules to midgut-ilial juncture).

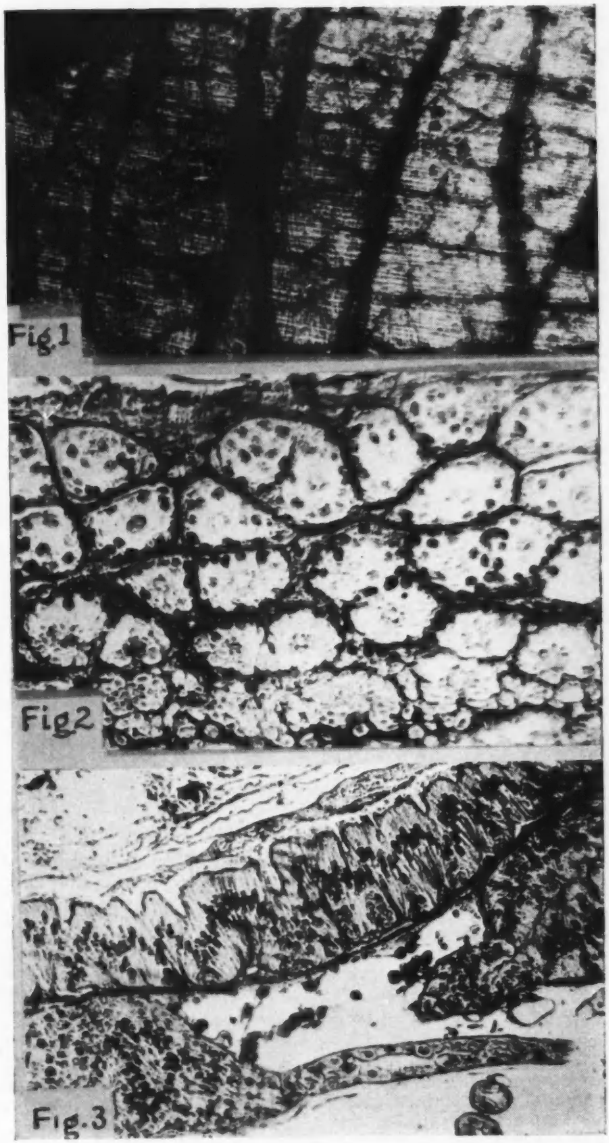
Fig.1
Fig2
Fig.3

reference to a variety of connective tissues in several silkworms. The discussion of connective tissue in the midgut of certain grasshoppers is touched on by Tietz (1923) for the Carolina locust, by Woodruff (1932–1934) in certain other forms, in some detail, and by Hodges IV (1936) in *Melanoplus differentialis* and *Locusta migratoria*.

Wermel (1938) in his brief treatment of connective tissue in the body of the silkworm larvae makes the significant statement "das Bindegewebe der Insekten ist bisher wenig untersucht worden . . ." and further on he explains the scarcity of researches on this tissue in insects by reference to difficulties of observation and general neglect. All available descriptions and the few relevant figures still leave much to the imagination. It is therefore the writer's intention modestly to extend the information on the distribution and pattern of the loose connective tissue associated with the midgut wall, as seen in the two lubbers referred to. Only one grasshopper, *Brachystola*, is here figured in detail, the other being represented by fig. 1 only. However, the same facts in general apply to both species.

METHODS USED

In connection with the more inclusive study of the internal anatomy of these grasshoppers, many hundreds of specimens, fresh or Bouin's

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EXPLANATION OF PLATE II

FIG. 4. Semi-tangential section cut through the midgut in the general direction of the line XX' of the next figure. In fact the line of cutting would be less steep. This line determines a plane at right angles to the paper of the Fig. (5). Approximate scale is indicated. A composite sketch. Compare with photo in Fig. 2.

FIG. 5. Generalized cross-sectional view of the midgut. Note that the connective tissue is prominent at the bounding and basal recesses between enteric epithelial units, and here the connective tissue thins out elbow said units and again tapers off as it rises between the units. In this way it is shown in sketch at left that the connective tissue forms cups about the base of epithelial masses. These are further crowded to form an open honeycomb structure, appearing in basal section as a network or reticulum.

ABBREVIATIONS USED

B—Basal connective tissue (between basement membrane of epithelial units and surrounding musculature).
BB—Brush border (cilial fringe of authors) of intima of epithelial cells.
CM—Circular muscles.
CTN—Nucleus of connective tissue cells.
CTR—Reticulum or net formed of connective tissue.
Cr—Crypt or infolding of the epithelial intima facing the lumen of the midgut.
ECT—Connective tissue ("peritoneum") enveloping muscles of the outer gut surface.
ECTN—Nucleus of a cell of the foregoing.
Ent. Ep. B.—Border or basement membrane of the cells of the epithelial units.
Ent. Ep. U.—Enteric epithelial mass or unit—part of "villus" of authors.
LM—Longitudinal muscles overlying circular muscles of gut.
MT—Malpighian tubules.
Nd—Nidus or compact cluster of new cells, basal in enteric units.
PM—Peritrophic membrane adjacent to brush border of epithelium in gut lumen.
Swls—Sidewalls, or projections from basally placed connective tissue, wedged between enteric epithelial units.
Tr—Tracheae and tracheoles in periventricular sinus and within connective tissue of gut.

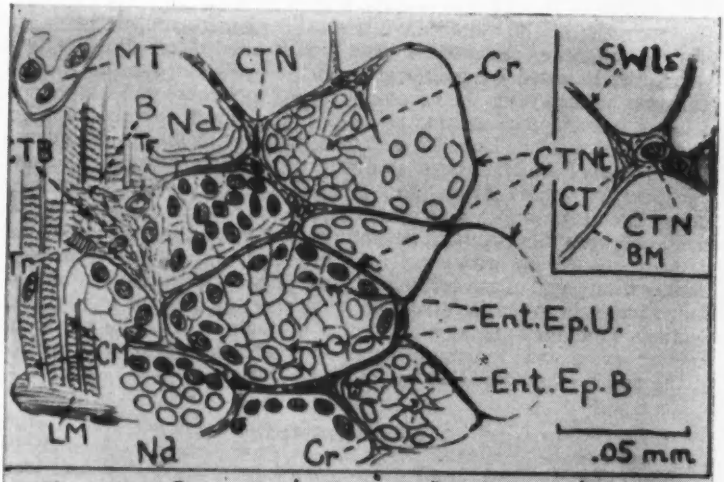

FIG. 4.- Semi-tangential section through XX' (below).

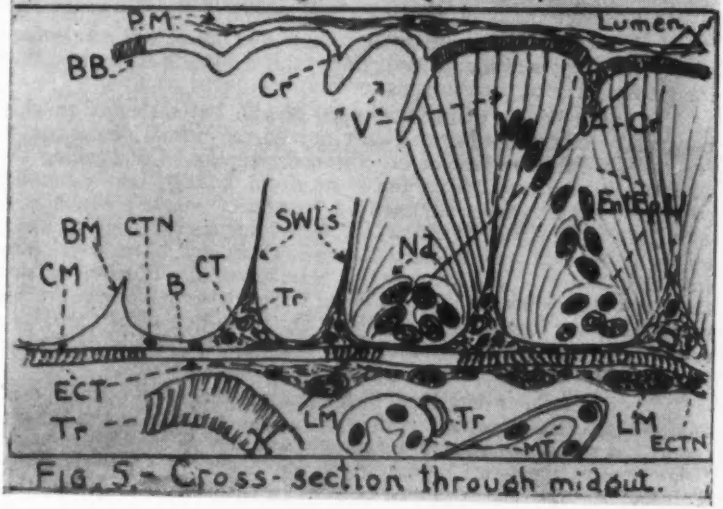

FIG. 5.- Cross-section through midgut.

injected, alcohol preserved, were used. Of these about two hundred were examined with reference to the present study.

Specimens of the ventriculo-intestinal region in case of the superficial examination pictured in fig. 1 were eroded in dilute sodium hydroxide, followed by gentle abrasion. For better contrast a bulk stain was applied after the necessary rinsing in alcohol and water. For detailed microscopic examination and photography, whole specimens were bulk-stained in Delafield's Hematoxylin, or stained, after mounting, in one of several triple stains for connective tissue. The best thickness for details lay in the region of 7 to 10 microns. The loose connective tissue appears as a continuous, somewhat stranded web or as an obscurely fibrous mesh depending on the fixation. It was rather sparsely nucleated, with nuclei of apparent disc shape, somewhat smaller than those of the epithelium, and with less chromatin substance. Individual cells when isolated were slenderly spindleform or irregular. Sections were available at any number of angles and one of particular interest was a wide tangential band observable in a horizontal section of the whole grasshopper abdomen, walls and all.

OBSERVATIONS

The triple stain as usual differentiated between muscle and loose connective tissue ground mass. The epithelium was also readily distinguishable either in its newest densest portion by a compact rich cytoplasm, by distinguishable cell boundaries or by an orange staining of less dense cytoplasm of the more developed cells.

The drawings, along with supporting photographs, will speak more clearly than words of the general relationships. It will be noticed that the general plan or pattern is as follows:

The epithelium is hardly composed of villi but rather of roughly polygonal clusters of elongated cells around an intimal depression or crypt. This, for the lack of an official designation, I am calling the enteric epithelial unit. This unit is set down, basally, into a cup-like container, one of many such, as in the foundation wax of a new honeycomb, and upon a general carpet-like sheet lying over the outer surface of the epithelium and between the epithelium and their enveloping enteric cylinder of finely placed circular muscles. Finally, outside these and closely invested in additional loose connective tissue, are the wider band-like longitudinal muscles. Sections often show these last-named muscles as quite separate from the gut wall, and in such cases their connective tissue wrapping is made more obvious.

The exact cellular detail and histological classification of the species of connective tissue encountered is not made an issue in the present report but rather the general appearance and the peculiar distribution. A later report is planned to more rigorously display the finer structure. This had already been suggested at least for certain grasshoppers other than the giant lubbers by the writers previously referred to. Wermel's suggestions point to other observations that should be made as to the exact character of connective tissue as applied to certain regions and to certain insects.

The most noticeable region of connective tissue is seen in sections, in the triangular recesses at the bases of the epithelial units. At such places one sees loose connective tissue ground mass, some nuclei of the sort described, and often sections of the small tracheae which typically penetrate connective tissue elsewhere in the gut and elsewhere in the body cavity.

The appropriateness of the term Connective Tissue, Reticulum or Net is seen in the eroded and teased specimen, and in more or less tangential sections. A term meaning "resembling honeycomb foundation" if such there were, would be more appropriate as it considers the third dimension. The wedge-like connective tissue "risers" or interepithelial wedges extend up between the units somewhat indefinitely, but probably about half the distance from outer gut wall to inner brush border. Semi-tangential sections show a little way from the outer gut wall very distinct between the epithelial units; in densely stained material, as solid walls with occasional compressed nuclei. These nuclei are not to be confused with those of the epithelial cells with their larger nuclei, plump in all directions, and larger, richer in chromatin granules. Nor is there any suspicion of the smaller, flattened connective tissue nuclei being misplaced nuclei of the epithelium. In epithelium more remote from the gut wall and nearer the gut lumen the connective tissue disappears from view and is finally replaced by non-nucleated cell apices quite loosely aggregated.

It is presumed that further study will show the described connective tissue distribution and pattern to be common at least to the Acridians and since it has been referred at least to a beetle, several silkworms and Cybister, it is reasonable to presume its more general occurrence in insects as a gut element, if not in general peritoneum.

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THE ENTOMOLOGICAL SOCIETY OF AMERICA

PROCEEDINGS OF THE FORTIETH ANNUAL MEETING

St. Louis, Mo., March 27, 28 and 29, 1946

The Entomological Society of America held its fortieth annual meeting on Wednesday, Thursday, and Friday, March 27–29, 1946, in conjunction with the annual meeting of the AAAS, with Headquarters in the New Hotel Jefferson, where the meetings were held. The North Central States Branch of the American Association of Economic Entomologists met at the same time and the two groups covered one joint session and sponsored the Entomologists' Banquet.

The attendance of the two entomological groups was about 200. Many others would undoubtedly have come to the meetings except for inability to obtain reservations.

The program presented at the three-day meeting follows:

Wednesday Morning, March 27, 10 A. M.

President Rehn called the session to order and announced the appointment of the following committees:

Nominating Committee—C. E. Mickel, Chairman; R. H. Beamer, Curtis Sabrosky.

Resolutions Committee—H. B. Hungerford, Chairman; J. C. Bradley, E. Gorton Linsley.

The following papers were presented:

1. The Salticidae of Panama (spiders) (by title). A. CHICKERING, Albion, Michigan.
2. The Comparative Anatomy of the Internal Genitalia of some *Tischeria* (Lepidoptera) (by title). J. L. WILLIAMS, Lincoln University, Pennsylvania.
3. The Present Status of the Insect Collections in Europe, (15 min.). MAJOR JOHN W. BAILEY, U. S. Army.
4. The Condition of Some of the Italian and German Insect Collections, (15 min.). B. D. BURKS, Illinois Natural History Survey.
5. Entomology in Japan, (15 min.). J. LINSLEY GRESSITT, St. Louis, Missouri.

Wednesday Afternoon, March 27, 1:30 P. M.

Presentation of Papers, continued:

1. What is an Insect? (15 min., lantern). J. CHESTER BRADLEY, Cornell University.
2. Identification of Female Anophelines of the United States, (15 min., lantern). R. L. USINGER, U. S. P. H. S.
3. Taxonomic Studies in Corixidae, (15 min., lantern). H. B. HUNGERFORD, University of Kansas.
4. An Undescribed Eversible Gland in the Larva of *Chlaenius* (Coleoptera, Carabidae), (10 min., lantern). W. P. HAYES, University of Illinois, and and H. F. CHU, Urbana, Illinois.
5. The Number of Gastric Caeca in Some Larval Scarabaeoidea (7 min., lantern) (by title). Z. P. METCALF, University of North Carolina.

6. The Transmission of *Litomosoides carini*, Filarid Parasite of the Cotton Rat, by the Tropical Rat Mite, *Liponyssus bacoti*, (15 min., lantern). ROGER W. WILLIAMS and HAROLD W. BROWN, U. S. Navy.
7. An Analysis of the Temperature Coefficients of DDT Action, (15 min., lantern). HSING-YAN FAN, University of Minnesota.
8. Biology of Dermestidae (15 min.). E. GORTON LINSLEY, University of California.
9. The Breaking of Diapause in Eggs of the Forest Tent Caterpillar, (15 min., lantern). A. C. HODSON, University of California.
10. The Metamorphosis of the Cephalic Ganglia of the Mosquito, (15 min.). WILLIAM ROGOFF, East Haven, Connecticut.
11. The Development of *Tribolium confusum* Duv. on Edible Soy Products, (15 min., lantern). C. E. MICKEL, University of Minnesota.

Thursday Morning, March 28, 10 A. M.

JOINT SESSION WITH NORTH CENTRAL STATES BRANCH

The joint session of the Entomological Society of America and the North Central States Branch was opened by J. J. Davis, President, North Central States Branch, in the chair, and the following program was presented:

1. Greetings from the National Societies and Remarks by CLAY LYLE, President of the American Association of Economic Entomologists and JAMES A. G. REHN, President of the Entomological Society of America.
2. The History, Organization, and Activities of the Insect Control Committee of of the Office of Scientific Research and Development, CLYDE KEARNS, University of Illinois.
3. The Outlook of Entomology in the National Science Foundation. Discussion from the floor.
4. Summary of Insect Conditions for 1945 and the Outlook for 1946, P. N. ANNAND, Bureau of Entomology and Plant Quarantine.

Appointment of committees.

Thursday Afternoon, March 28, 1:30 P. M.

The Entomological Society continued the program of presentation of papers, Vice-President E. Gorton Linsley in the chair.

1. Some Preliminary Determinations of Histamine and Related Substances in Insect Tissues, (15 min.). LAURENCE K. CUTKOMP, University of Minnesota.
2. A Modified Interpretation of the Chemical Organization of the Cuticle of Insects, (15 min.). A. GLENN RICHARDS, University of Minnesota.
3. Stability in Family Names; Some Principles and Problems, (15 min.). CURTIS W. SABROSKY, U. S. P. H. S.
4. Nearctic *Stenus* of the *Croceatus* Group (Coleoptera, Staphylinidae), (10 min., lantern). M. W. SANDERSON, Illinois Natural History Survey.
5. Ectoparasites of the Common Rat, (15 min., lantern). R. W. STRANDTMANN, University of Texas.
6. Distribution and Host Relationships of the Polyctenidae (10 min., lantern). ROBERT L. USINGER, U. S. P. H. S.
7. *Trombicula deliensis* and its Relation to Scrub Typhus in Assam, India, (15 min.). CAPT. ROBERT TRAUB, Typhus Commission.

Chairman Linsley adjourned the presentation of papers and turned the meeting over to President Rehn for the annual business meeting, which is reported here at the end of the presentation program.

Thursday Evening, March 28, 7 P. M.

The entomologists' banquet was held in the Crystal Room, with J. J. Davis as Toastmaster.

After the banquet, President Rehn gave the Presidential Address of the Entomological Society, "Entomology as an Integrant Part of Zoological Science."

Friday Morning, March 29, 9:30 A. M.

The Entomological Society held a joint program with the Ecological Society of America, Mary Talbot, Chairman. The following papers were presented:

1. Temperature Tolerations of Aquatic Insects in Mexico, (10 min.). H. D. THOMAS, North Park College, Chicago, Illinois.
2. Population Movement and Length of Life in *Colias* Adults (Alfalfa Butterfly), (10 min.). W. HOVANITZ, University of Michigan.
3. Camouflage and the Infra Red, (10 min.). LORUS J. MILNE, University of Pennsylvania.
4. Population and Control Studies of the Palau Gnat on Peleliu, Western Caroline Islands, (15 min.). C. K. DORSEY, Webster Groves, Missouri.
5. Biotic Barriers to Termite Distribution, (15 min., lantern). ALFRED E. EMERSON, University of Chicago.
6. Differential Feeding in Relation to Local Distribution of Grasshoppers, (10 min., lantern). F. B. ISELY, Trinity University.
7. Predaceous Conocephalinae, (5 min.). F. B. ISELY, Trinity University.
8. Comparative Toxicity of p-Halogen Analogs of DDT to Fish and Mosquito Larvae, (10 min., lantern). EUGENE P. ODUM and W. T. SUMERFORD, University of Georgia.
9. The Application of Average Minimum Daily Temperatures to Redefine Merriam's Life Zones in Eastern North America, (15 min., lantern). J. CHESTER BRADLEY, Cornell University.
10. Effects of Parasite Population Density on Populations of Host and Parasite, (10 min., lantern), PAUL DE BACH and H. S. SMITH, University of California Citrus Experiment Station, Riverside, California.

Exhibits

Two exhibits were shown by members of the Society, as follows:

1. Mosquito Portraits, ROBERT L. USINGER, U. S. Public Health Service.
2. Japanese Entomological Publications, CHARLES L. REMINGTON and J. LINSLEY GRESSITT.

Thursday Afternoon, March 28, 3:15 P. M.

President Rehn called to order the annual business meeting of the Entomological Society of America.

REPORT OF THE SECRETARY

Executive Committee Activities During the Year 1945:

Twenty-five members were elected to membership by mail ballot. A Committee on Biographies was appointed by President Rehn to collect obituaries and other biographical data for the Society. During the year DR. C. H. KENNEDY resigned as Managing Editor of the "Annals," and DR. A. W. LINDSEY was appointed to fill the post. These and other items of business, up to November 1, 1945, have been published in the Annals.

On December 5 PRESIDENT REHN appointed DR. R. L. WEBSTER of the Agricultural Experiment Station at Pullman, Washington, as the Society's representative of the inauguration of DR. WILSON MARTINDALE COMPTON as President of the State College of Washington, at Pullman, Washington, on December 11.

PRESIDENT REHN appointed an Auditing Committee of H. O. DEAY, D. M. DELONG, B. T. HODGES, and R. A. BLANCHARD, *Chairman*, and appointed PHIL RAU and C. K. DORSEY to a joint Local Arrangements Committee.

Annual Executive Committee Meeting:

The Executive Committee convened in Private Dining Room No. 5 at the New Hotel Jefferson at 8:00 P. M., March 27, 1946, with the following members present: JAMES A. G. REHN, E. GORTON LINSLEY, A. W. LINDSEY, HERBERT H. ROSS. PRESIDENT REHN designated the following alternates who were also present: H. B. HUNGERFORD, E. N. CORY, CLAY LYLE, ROBERT USINGER, J. CHESTER BRADLEY, and M. W. SANDERSON.

Twenty-eight persons were elected as members of the Society, listed in the Section of New Members. The following have resigned during the year: ANDRE AUDANT, EDWARD WILLIAM BAKER, MILTON D. FARRAR, CARL FILSINGER, BERTA B. KESSEL, HELEN C. MANK, MANLIO MANZELLI, RALPH B. MARCH, RAIFORD A. ROBERTS, P. E. SCHAEFER, GEORGE K. SCHUMAKER, IRVING SIEGEL, S. W. SIMMONS, HAROLD M. STEINER, RAYMOND L. TAYLOR, THOMAS COBB WATKINS, and WAYNE L. HOWE.

The following have been automatically dropped as members either because of failure for three or more years to pay dues, or because they cannot be reached: GEORGE W. BARBER, GALE GATES BLEASDELL, IVAN CHESSUM BROOKS, RALPH J. BUSHNELL, ROY W. CHAMBERLAIN, THEODOR R. GARDNER, JOHN D. HITCHCOCK, H. G. JOHNSTON, GUY F. MACLEOD, ARTHUR PORTER MCKINSTRY, DARRELL R. MADDOCK, ROBERT M. MELAMPY, SEATON C. MENDALL, F. W. MILLER, WILLIAM PITT MORGAN, JAMES HUBERT PEPPER, MANUEL M. PETRAKIS, RITCHARD READE, MYRON W. SMITH, and JOSEPH BENJAMIN TUCK.

The Executive Committee elected the following Fellows: CHARLES T. GREENE, F. B. ISELY, F. M. JONES, M. D. LEONARD. L .E. ROZEBOOM, CLYDE F. SMITH, C. WILLEMSE, and ELWOOD C. ZIMMERMAN.

The Society has suffered the loss by death of the following nine members: JOHN BARLOW, WILLIAM T. DAVIS, T. H. FRISON, U. C. LOFTIN, EDITH W. MANK, JOHN D. MAPLE, R. C. SHANNON, RALPH H. SMITH, and FRANK H. TAYLOR. Following the announcement of these losses to the Society, the members stood in silence in honor of the memory of those who have died in the last year.

It was moved and seconded that members having 35 years as a member in the Society and having attained the age of 65 be given the option of maintaining their membership without payment of dues and without receiving the Society's publications. Motion carried.

The following were elected to fill three vacancies on the Editorial Board: FRANK YEAGER, JOSEPH C. BEQUAERT, and WILLIAM PROCTER. These will serve through 1948.

The following were elected to fill the vacancies in the Thomas Say Foundation for a period of two years: HERBERT SCHWARZ and ROBERT USINGER for full terms, and H. H. Ross to fill the unexpired term of T. H. FRISON.

It was moved and seconded to contribute $100.00 to the support of Zoological Record. It was moved and seconded that the President and Secretary be empowered to meet with the President and Secretary of the American Association of Economic Entomologists to decide the time and place of the next annual meeting. Motion carried.

It was moved and seconded that it was the opinion of this committee that the Executive Committee has full power to appoint the Managing Editor and that the Editorial Board has full power to handle all matters concerned with the Annals including the responsibility for the stock. Motion carried.

It was moved and seconded that a sum up to $50.00 be allotted to the expenses of the American Committee on Entomological Nomenclature for 1945 and 1946. Motion carried.

The Executive Committee adjourned at 12:00 midnight.

Respectfully submitted,

HERBERT H. ROSS, *Secretary*.

It was moved and seconded that the Secretary's Report be accepted. Motion carried.

TREASURER'S REPORT

December 1, 1944, to March 14, 1946

Current Fund

RECEIPTS

Balance on hand December 1, 1944	$3,787.74
Life Memberships	100.00
Annual Dues	5,052.80
Total	$8,940.54

EXPENDITURES

Stamps, Envelopes, Printing, and Clerical Help	$ 213.83
Cost of 1944 Meeting	97.10
Annals, from September, 1944, to December, 1945, and reprints	4,823.35
Traveling Expenses of Secretary-Treasurer	51.42
Traveling Expenses, E. O. Essig, National Research Council	53.64
Miscellaneous	30.80
Permanent Fund	250.00
Zoological Record, Zoological Society of London	100.05
Total	$5,620.14
Balance	3,320.40
	$8,940.54

Permanent Fund

RECEIPTS

Balance as of December 1, 1944	$4,327.40
Live Memberships (from Current Fund)	250.00
Interest on War Bond	2.16
Interest on Savings Account	16.67
Liberty Bond	50.00
Balance in Permanent Fund	$4,646.23

Total Resources of Society

Balance in Permanent Fund	$4,646.23
Balance in Current Fund	3,320.40
Total Balance	$7,966.63

REPORT OF THE MANAGING EDITOR

The transfer of the editorship from Columbus to Granville has necessarily caused some difficulty in re-establishing an orderly routine. Thanks to Mr. J. B. Gerberich, who has been willing to care for the reserve stock of the Annals in Columbus, and to Mrs. Helen S. Lanman, Dr. Kennedy's secretary for many years, it has been possible to handle the bulk of sales and the entire mailing list as before. Mrs. Lanman is, of course, thoroughly familiar with this work. She has been interested in it and has wanted to continue the work as long as we need her. I cannot overemphasize my debt to her and to Mr. Gerberich.

The addressograph plates have been maintained at the mailing room of the Ohio State University. I have been able to arrange for the continuation of their service through the willingness of Miss Doris Cripps, an addressograph operator

at the mailing room, to handle our work on her own time. The arrangement involves a small additional expense, averaging about five dollars per issue.

All of the reserve stock of the Annals but a small supply shelved at O. S. U. has been shipped to Granville for storage until a business manager is chosen. This material, boxed for shipment, amounted to about one and one-half loads for a large trailer truck. We have fireproof storage for it in the Life Science Building at Denison, hence it is safe. The inefficiency of the present arrangement, however, is a source of worry. Since the disposal is temporary I have opened packing cases at intervals to fill orders for reprints, with the result that an order for a few dollars worth of reprints may consume two or three hours of my time in shifting heavy cases and sometimes opening one for the withdrawal of a single small reprint. The establishment of a permanent managership will, of course, make it possible to systematize a complete stock of this material for convenient withdrawal of separate items. We are using one large storeroom and part of another for the stock in its present state. Much of it may remain in packing cases as a reserve, but a complete series of back numbers and reprints will require a considerable amount of shelving. Once a moderate stock is shelved orders can be filled quickly and efficiently.

The editing of the Annals has offered less problems, since I was already familiar with the established routine. Although Columbus is 27 miles from Granville, it is our chief shopping center, hence I am able to combine the necessary visits to printer and engraver with other errands. I owe an apology to our authors for tardiness in returning drawings and cuts during the first year of my editorship, but this delay has now been largely cared for and returns will be made from now on soon after the material is published.

In editorial policy I have carried on with no considerable change, awaiting an opportunity for a conference with the editorial board. The inclusion of "News of the Moment" from time to time has seemed to Dr. Ross and me a desirable innovation to acquaint members with the more important items of Society business. It requires little more space than a full annual report and adds timeliness in the presentation of occasional items.

Some of the minor irritations of publication are soon to be removed. The printers have been troubled by insufficient help, hence several issues have appeared very late. I hoped that the March issue might be in the mail before the meeting, but I doubt that they succeeded in getting it out, although it has been in page proof since the 16th. We are to return to heavier paper with this issue—a welcome step from all points of view.

For the future several problems face us. Most important is the selection of a business manager. I quite agree with Dr. Kennedy that the full duties of the managing editor have become too great for one man to carry as a labor of love—indeed, too great for one man to carry on any basis if he has a responsible position as a source of livelihood. This problem was referred to the Editorial Board by the Council last year, but no member of the Board has been able to offer a helpful suggestion. We profit by our connection with Spahr and Glenn, the printers, hence it would be desirable to retain the management of the Annals in or near Columbus. Unfortunately the faculty of Denison University is too small to offer any candidates and I understand that no one at Ohio State University is interested.

A second problem relating to the purely editorial work troubles me. Frankly I feel that the editor should be connected with a large institution which has a department of entomology so that he could work with an assistant who could take over in emergencies.

Lastly the practical problem of cost must be faced. We have been paying close to $6.00 per page for printing and mailing. On my last visit to the printers they broke the news gently that an increase is to be expected. Since the cost of engraving is borne by our authors we are not concerned with possible increases there as a matter of Society financing. We have published a 610-page volume in 1945 partly because of government restrictions on paper and partly because we have caught up with our large accumulation of manuscripts. We had money to publish a larger volume if material had been available, and can do so in 1946 if manuscripts continue to come in as they have in recent weeks. I anticipate that the current meeting will bring in enough articles to carry us through several issues.

In conclusion I wish to express my appreciation to the Society for the honor and privilege of carrying on the work of the Annals. Whether I continue it or not I shall always be glad for having been able to do it during the last difficult war year when Doctor Kennedy's health made it necessary for him to resign after his long and able service to the Society.

Financial statement of the Granville office from the time of transfer from Columbus to the end of January, 1946. The books were balanced to this date instead of the end of the year 1945 because a few items of income received in 1945 were not deposited until January.

RECEIPTS

Balance transferred from Columbus	$135.84
Cash on hand at time of transfer	23.52
Received from authors for cuts	147.62
Received from sale of reprints	5.55
Contribution from Dr. William Procter	500.00
Total	$812.53

DISBURSEMENTS

Engraving	$163.25
Postage	17.30
Stationery	36.23
Storing back numbers and reprints	32.70
Addressing wrappers	22.50
Bank charge	.25
Balance in bank January 31	540.50
Total	$812.53

FINANCIAL STATEMENT OF THE COLUMBUS OFFICE

Funds received to January 1, 1946	$1,382.95
Expenditures and bank charges to January 1, 1946	974.40
Bank balance, January 1, 1946	408.55
Total	$1,382.95

Respectfully submitted,

A. W. LINDSEY, *Managing Editor.*

REPORT OF THE EDITOR AND TREASURER OF THE THOMAS SAY FOUNDATION

The Thomas Say Foundation was organized to publish entomological monographs which are not acceptable by commercial publishers because of small sales. Until recently the Foundation attempted to publish volumes without a "foundation" of money, depending on the sale of volumes for publication funds. As a result, the publication of the first three volumes has depended on sales with little to encourage publication of further volumes. However, by the first of 1945 the Foundation had **$571.32**, with a good supply of the first three volumes. As reported in our report a year ago, **$2,000.00** was provided by W. S. BLATCHLEY, increased by **$99.42** during the past year. In addition, **$1,000.00** has been provided by DR. HYMAN, president of Velsicol Corporation, so that we now have at last a Foundation totaling **$3,734.32**, as shown in the following financial report.

A valuable manuscript is available and ready to be published as soon as a suitable publisher will accept our manuscript. It is to be hoped this manuscript will be published during the present year.

The financial report follows:

RECEIPTS

Balance on hand, December 1, 1944	$2,571.32	
1945 sales of Volume I—2 @ $3.00	6.00	
1945 sales of Volume I—1 @ $2.65	2.65	
1945 sales of Volume II—2 @ $5.00	10.00	
1945 sales of Volume II—1 @ $4.50	4.50	
1945 sales of Volume III—1 @ $4.00	4.00	
Interest to December 31, 1945	38.18	
Received from W. S. Blatchley Trust	99.42	
Received from Dr. Hyman	1,000.00	
Total Receipts		$3,736.07

EXPENDITURES

Postage	$ 1.75	
Balance in Purdue State Bank, March 1, 1946		$3,734.32

Respectfully submitted,

J. J. DAVIS, *Editor and Treasurer.*

REPORT OF THE AUDITING COMMITTEE

We, the undersigned, beg to report that we have examined the accounts of the Treasurer of the Entomological Society of America, the Editor and Retiring Editor of the Annals of the Society, and the Treasurer of the Thomas Say Foundation and have found them to be balanced and correct as of March 1, 1946.

The accounts of the Treasurer, H. H. Ross, were examined by R. A. BLANCHARD; those of the Editor, A. W. LINDSEY, and the retiring Editor, C. H. KENNEDY, by A. B. HODGES and D. M. DELONG; and those of the Treasurer of the Thomas Say Foundation by H. O. DEAY.

Respectfully submitted,

DWIGHT M. DELONG,
HOWARD O. DEAY,
R. A. BLANCHARD, *Chairman.*

It was moved and seconded that the reports of the Treasurer, Managing Editor, and Treasurer of the Thomas Say Foundation be adopted, together with the report of the Auditing Committee. Motion carried.

REPORT OF THE JOINT COMMITTEE ON COORDINATION OF ENTOMOLOGY WITH THE WAR EFFORT

To the President and Executive Committee of the American Association of Economic Entomology and of the Entomological Society of America, respectively:

Your committee has been inactive during the year insofar as formal meetings and modifications of the program heretofore reported are concerned.

The original charter of the committee charged it with the duty of directing the resources of the entomological profession into those channels where entomology should most effectively promote the over-all war effort of the nation.

Inasmuch as the activities associated with the placement of entomologists in the armed forces where their training and abilities could be most effectively utilized were very properly delegated to a special committee, the Coordination Committee had no direct part in that work. Your committee did, however, maintain the position that the members of the entomological profession as a group should not be given preferential treatment with respect to induction into the

armed services on the grounds that they were needed at home. This was because of a strong conviction, amply supported by subsequent events which are now history, that entomologists could be even more valuable in the armed forces than at home.

The committee dedicated the entomological profession to the pledge that those members who, for one reason or another, were not qualified for military service increase their efforts, both individually and cooperatively, to the end that national health be maintained and that losses from insect pests in food production be reduced to the lowest possible level.

The earliest and most important action of your committee was to inaugurate a comprehensive plan for cooperation among entomologists and with other agencies and industries. To this end a carefully chosen system of committees and subcommittees was set up. Entomologists from all over the country were given specific assignments which were carried out far beyond the expectations of the parent committee. Indeed, abilities and skills were discovered which previously were not known to exist.

From time to time, minor changes were made in the first formal organization of the committee's over-all plan but these were relatively few.

The last assembly of the committee was held December, 1944, in connection with the New York meetings of the American Association of Economic Entomologists and the Entomological Society of America. Because of the trend the war took early this year and because the existing program was operating smoothly, there seemed no justification to call the committee together in 1945. However, the 1944 personnel, together with A. Glenn Richards, who was appointed by President Rehn as an additional member of the committee, was willing to continue to serve when requested to do so by Presidents Van Dine and Rehn, and to stand by for any emergency that might arise.

In view of the significant service that entomology contributed in winning the war, your committee recommends that the officers and Executive Committees of the American Association of Economic Entomologists and of the Entomological Society of America give serious consideration to the advisability of assembling and publishing an historical record of the services rendered by entomology which were concerned directly with the war effort. This should include both the foreign and home fronts.

Finally, we commend entomologists for the part played by our profession in World War II. Especially do we salute those who served in the armed forces. We cannot help but be proud of the fact that among our number is found one of the most decorated men in the service.

Respectfully submitted,

D. L. Van Dine, *Ex-Officio*,
J. A. G. Rehn, *Ex-Officio*,
E. N. Cory,
L. M. Peairs,
S. A. Graham,
Avery S. Hoyt,
E. F. Phillips,
A. Glenn Richards,
P. D. Sanders,
J. S. Houser, *Chairman*.

On motion the report of the Joint Committee of Coordination of Entomology with the War Effort was accepted and the recommendations referred to the Executive Committee.

AMENDMENT TO CONSTITUTION

Pursuant to the notice of a proposed amendment to the Constitution adopted at the New York meetings, it was moved and seconded that the following sentence be added to Section 3, Article 4, of the Society's Constitution: "In the event that such a meeting is not held, the officers shall continue to function until the next annual meeting." Motion carried.

PROPOSED NEW PUBLICATION

JOURNAL OF INSECT PHYSIOLOGY AND TOXICOLOGY

This subject was introduced by DR. MAX DAY with additional discussion by A. G. RICHARDS, JR., and H. H. ROSS. After discussion from the floor, it was moved and seconded that the President be instructed to appoint a committee of three to investigate the problem, to contact the AAEE to ascertain its degree of interest and possible co-sponsorship, and after due consideration and suitable arrangements to proceed with steps necessary to initiate such action as may seem desirable and feasible. Motion carried. PRESIDENT REHN then nominated DR. FRANKLIN YEAGER, *Chairman*, DR. CLYDE KEARNS and DR. A. G. RICHARDS, JR., as a committee of three to put this motion into effect.

REPORT OF THE COMMITTEE ON RESOLUTIONS

1. WHEREAS, planning and arrangements for national scientific meetings under the present post-war conditions involve problems of the greatest difficulty,

Therefore be it Resolved, that we express our appreciation to the Joint Committee for Local Arrangements: J. A. DENNING, *Chairman;* PHIL RAU, J. C. DAWSON, and C. K. DORSEY; to the Officers of the Society; and to the American Association for the Advancement of Science, for their efforts on behalf of this meeting.

2. WHEREAS, accommodations for the present meeting were most difficult to provide,

Therefore be it Resolved, that we express our gratitude to the management of the Jefferson Hotel for the use of their rooms and other facilities and to the St. Louis Housing Bureau for its efforts to make housing facilities available.

3. WHEREAS, there has been a tendency in recent years to overlook the role of Entomology in the general field of Zoology,

Therefore be it Resolved, that we express our appreciation to our President, JAMES A. G. REHN, for his willingness to address the Society on the important subject of "Entomology as an Integrant Part of Zoological Science."

4. WHEREAS, the accurate identification of insect and other arthopod vectors of disease is of utmost importance under both war and peacetime conditions,

Therefore be it Resolved, that the Society commend the U. S. Public Health Service for its film strip entitled "Identification of Female Anophelines of the United States" and similar educational taxonomic projects.

5. WHEREAS, during the past year our Society has suffered the loss of several of its members through death,

Therefore be it Resolved, that we express our appreciation for the services of these members through an expression of sympathy to be sent to a surviving relative of each deceased member.

6. WHEREAS, DR. WILLIAM PROCTER has once more generously contributed a sum of $500.00 to the Annals of the Entomological Society of America for the year 1945–1946,

Therefore be it Resolved, that the sincere appreciation of the Society be expressed to him for his generous confidence and support.

7. WHEREAS, DR. JULIUS HYMAN has generously contributed a sum of $1,000.00 to the Thomas Say Foundation,

Therefore be it Resolved, that the sincere appreciation of the Society be expressed to him for his generous support.

Respectfully submitted,

J. C. BRADLEY,
E. GORTON LINSLEY,
H. B. HUNGERFORD, *Chairman.*

On motion the report of the Committee on Resolutions was accepted as read.

REPORT OF THE NOMINATING COMMITTEE

Your committee places for nomination the following Fellows of the Entomological Society of America to fill the designated offices for the year 1946:

President—C. F. W. MUESEBECK, Bureau of Entomology and Plant Quarantine, Washington, D. C.

First Vice-President—S. A. GRAHAM, University of Michigan, Ann Arbor, Michigan.

Second Vice-President—ALVAH PETERSON, Ohio State University, Columbus, Ohio.

Secretary-Treasurer—H. H. ROSS, Illinois Natural History Survey, Urbana, Illinois.

Executive Committee—
ROBERT MATHESON, Cornell University, Ithaca, New York.
R. L. USINGER, USPHS, Atlanta, Georgia.

Councilors to the American Association for the Advancement of Science—
STANLEY W. BROMLEY, Bartlett Tree Research Laboratories, Stamford, Conn.
ROGER B. FRIEND, Agricultural Experiment Station, New Haven, Conn.

Respectfully submitted,

R. H. BEAMER,
CURTIS SABROSKY,
CLARENCE E. MICKEL, *Chairman*.

On motion the report of the Nominating Committee was accepted and the Secretary was instructed to cast a unanimous ballot for the persons nominated. This being done, they were duly elected.

President Rehn introduced for discussion a report submitted by Dr. Robert H. Griggs regarding the educational situation in agriculture and forestry. President Rehn proposed that the incoming President study the matter and appoint a committee to approach the AAEE with the thought of obtaining similar data for the entomologists, and investigating the relation of the Entomological Society of America to the proposed National Research Foundation. After considerable discussion it was decided to place this matter before the incoming President for his action.

Following the transaction of the above business, the meeting adjourned.

NEW MEMBERS

ELECTED MARCH, 1946

H. BRUCE BOUDREAUX, Dept. of Zoology, Louisiana State University, Box 8729, Baton Rouge 13, Louisiana.
FRANK A. COWAN, 2201 Schulle St., Austin, Texas.
SAM MADISON COX, 127 North Tenth Ave. East, Duluth 5, Minnesota.
GEORGE H. EBERLEIN, West Concord, Massachusetts.
PEDRO GALINDO, Campana Anti-Malarica, Ministerio de Pr. Social, Panama, Republic of Panama.
ALBRO T. GAUL, 401 Washington Ave., Brooklyn 5, New York.
ALMA RUTLEDGE GOLDBERG, JR., 621 St. Johns Road, Baltimore 10, Maryland.
DONALD ROSS JOHNSON, 6409 Tahoma Ave., Chicago 30, Illinois.
JACK D. JONES, Box 212, R. R. No. 1, Fort Collins, Colorado.
WILLIAM W. JUDD, 297 Glen Road, Toronto, Ontario, Canada.
HARRY H. LAIDLOW, JR., F.S.C. Laboratory, 281 South St., Jamaica Plain 30, Massachusetts.
DALE R. LINDSAY, P. O. Box 932, Pharr, Texas.

CARL E. LUDWIG, 19 Gates St., Manchester, New Hampshire.
WILLIAM R. M. MASON, 11537 97th St., Edmonton, Alberta, Canada.
RALPH H. MILLER, 581 Euclid Ave., Apt. 5, Upland, California.
TOSHIO NAKAJIMA, Entomological Institute, Imperial University, Hokkaido, Sapporo, Japan.
W. E. RICKER, Indiana University, Bloomington, Indiana.
ROY M. SALLEE, 131 N. Normal St., Macomb, Illinois.
EDWIN L. SEABROOK, County Courthouse Annex, West Palm Beach, Florida.
SHOICHI SAKAGAMI, Entomological Institute, Imperial University, Sapporo, Japan.
TAKAHISA SAWAMOTO, Hokkaido Forest Experiment Station, Toyohira 5 jo, 13 chome, Sapporo, Japan.
S. S. SHARP, Dept. of Zoology, Iowa State College, Ames, Iowa.
EDWARD A. STEINHAUS, Insect Pathology Laboratory, 112 Agricultural Hall, University of California, Berkeley 4, California.
HIROSI TAKAHASI, Entomological Institute, Hokkaido Imperial University, Sapporo, Japan.
CLIFFORD THERIAULT DE MONTBLANC, 405 Metcalfe Ave., Montreal, Canada.
CHIHISA WATANABE, Entomological Institute, Imperial University, Sapporo, Japan.
WYNNFIELD Y. WATSON, 1C Benlamond Ave., Toronto 13, Canada.
FLOYD WERNER, 702 Pearl St., Ottawa, Illinois.

THE ENTOMOLOGICAL SOCIETY OF AMERICA

LIST OF MEMBERS

(MARCH, 1946)

In this list, which is arranged alphabetically, members are given in lower case type, Fellows in small caps and Honorary Fellows in capitals. The year of admission to membership is given before the name, and of election to Fellowship and Honorary Fellowship in parenthesis following the address. Names of Life Members are indicated by asterisk (*) and the special field of work in italics. Ch. indicates Charter Member, 1906.

A

'39. Aamodt, T. L., State Entomologist's Office, University Farm, St. Paul, Minn.
'39. Ackermann, Otto, 639 Walnut Street, Irwin, Pa. *Lepidoptera.*
'27. ADAMS, C. F., State Board of Health, Jefferson City, Mo. (F. '29). *Diptera.*
'40. Ahrens, Carsten, 3461 Harrisburg St., Pittsburgh 4, Pa. *Odonata.*
'10. ALEXANDER, CHARLES P., Massachusetts State College, Amherst, Mass. (F. '20). *Tipulidae.*
'33. Alexander, E. Gordon, Dept. of Biology, Univ. of Colorado, Boulder, Colo. *Orthoptera.*
'13. ALLEE, W. C., Zoology Building, Univ. of Chicago, Chicago, Ill. (F. '39). *Behavior.*
'25. ALLEN, H. W., Box 150, Moorestown, N. J. (F. '40). *Tiphiidae, Tachinidae.*
'42. Allen, Theodore, 2520 Mulberry Ave., Muscatine, Iowa.
'32. Amos, John M., 403 State Office Bldg., Nashville 3, Tenn. *Coccidae, Cerambycidae.*
'30. Anderson, Edwin J., Frear Laboratory, State College, Pa. *Beekeeping.*
'29. Anderson, Lauren D., Virginia Truck Exper. Sta., P. O. Box 2160, Norfolk 1, Va. *Gerridae.*
'37. Anderson, William H., Room 429, U. S. National Museum, Washington 25, D. C. *Coleopterous larvae.*
'39. Andre, Floyd, Office of Exper. Sta., U. S. D. A., Washington, D. C. *Thysanoptera.*
'37. Anduze, Pablo J., Instituto Nacional de Higiene, Ministerio de Sanidad y Asistencia Social, Caracas, Venezuela. *Culicidae.*
'32. ANNAND, P. N., Bur. of Ent. and Pl. Quar., Washington, D. C. (F. '39). *Aphids.*
'28. App, Bernard A., Box 215, Burgaw, N. C. *Economic Entomology.*
'40. Archer, Allan F., 312 East Vine St., Decatur, Ala. *Arachnida.*
'23. Armstrong, T., Ent. Lab., Vineland Sta., Ontario, Canada. *Scarabaeidae.*
'36. Ashton, Donald F., 2711 Van Dyke Ave., Raleigh, N. C. *Culicidae.*
'37. Assmuth, Rev. Joseph, Fordham Univ., New York, N. Y. *Isoptera.*
'42. Atkins, Edward L., Jr., Route 1, Smithshire, Ill.
'34. Au, Sung Hin, 1911 Dole St., Honolulu 33, Hawaii. *Aphids.*
'33. AVINOFF, A., Hidden Valley, Locust Valley, Long Island, N. Y. (F. '39). *Lepidoptera.*

B

'37. Babers, Frank H., P. O. Box 3391, Orlando, Fla. *Physiology.*
Ch. *BACK, E. A., Bur. of Ent. and Pl. Quar., Washington, D. C. (F. '38). *Asilidae, Aleyrodidae.*
'39. Badertscher, A. Edison, 103 Bonnie Hill Road, Towson, Baltimore 4, Md. *Insecticides.*
'21. BAERG, W. J., Univ. of Arkansas, Fayetteville, Ark. (F. '32). *Poisonous Arthropods.*

'30. *Bailey, J. W., 27 Willway Road, Richmond, Va. *Myriapoda.*
'11. BAKER, A. C., Apartado Number 3, Colonia Anahuac, D. F., Mexico. (F. '29). *Aphididae, Aleyrodidae.*
'22. Baker, Howard, Bur. of Ent. and Pl. Quar., Washington 25, D. C. *Apple and Pecan Insects.*
'36. Baker, Walter C., Carter Memorial Laboratory, P. O. Box 547, Savannah, Ga. *Toxicology.*
'28. BALCH, R. E., Dominion Ent. Lab., Fredericton, New Brunswick, Canada. (F. '44). *Forest Insects.*
'20. BALDUF, W. V., 308 Entomology Bldg., Univ. of Illinois, Urbana, Ill. (F. '40). *Entomophagous Insects.*
'45. Ball, William Howard, Box 392, College Park, Md.
'43. Balock, John W., Laboratorio Entomologico, Apartado 3, Colonia Anahuac, D. F., Mexico.
'38. Ballou, Charles H., Instituto Experimental de Agricultura, El Valle, Distrito Federal, Venezuela. *Economic Entomology.*
'08. BANKS, NATHAN, 103 Norfolk St., Holliston, Mass. (F. '14, H. F. '45).
Ch. BARBER, H. G., 143 East Third Ave., Roselle, N. J. (F. '30). *Hemiptera.*
Ch. BARBER, H. S., U. S. National Museum, Washington 25, D. C. (F. '28). *Coleoptera.*
'23. Bare, Clarence O., Box 7062, Richmond 21, Va. *Notonectidae.*
'26. BARNES, H. F., Rothamsted Exper. Sta., Harpenden, Herts, England. (F. '37). *Cecidomyiidae.*
'28. Barnes, O. L. Address unknown.
'43. Barnes, Ralph C., U.S.P.H.S., 605 Volunteer Bldg., Atlanta, Ga.
'40. Barnett, Herbert C., Univ. of Minnesota, Dept. of Entomology, University Farm, St. Paul, Minn.
'39. Barrett, John P., care of Armour & Co., Dept. of Chemical Research, Union Stock Yards, Chicago 9, Ill. *Calliphoridae.*
'41. Barrett, Paul H., 302 Cowley, East Lansing, Mich. *Aquatic Insects.*
'35. Barrett, W. L., Jr., Box 208, Dallas 1, Texas. *Diptera.*
'39. Bartlett, Lawrence M., Fernald Hall, Massachusetts State College, Amherst, Mass. *Ephemeroptera.*
'18. BASINGER, A. J., Citrus Experiment Sta., Riverside, Calif. (F. '41). *Calliphoridae.*
'31. BATES, MARSTON, Rockefeller Foundation, Apartado 757, Villavicencio, Colombia, (F. '40). *Diptera, Trypetidae.*
'24. BEAMER, RAYMOND H., 1000 Missouri St., Lawrence, Kans. (F. '34). *Homoptera, Cicadellidae.*
'34. Beck, Elmer W., 626 Virginia Ave., Toledo 10, Ohio. *Parasites European Corn Borer.*
'29. Bedard, W. Delles, 335 Giannini Hall, Univ. of California, Berkeley, Calif. *Scolytidae, Braconidae.*
'20. Bedford, Hugh W., Gov. Ent., Agric. Res. Service, Ent. Sec., Wad Medani, Sudan, Africa.
'43. BEEBE, WILLIAM, New York Zoological Society, Zoological Park, Bronx Park, New York, N. Y. (F. '44).
'42. Belkin, John N., Dept. of Entomology, Agr. Exp. Sta., New Brunswick, N. J.
'25. BELL, ERNEST L., 150–17 Roosevelt Ave., Flushing, N. Y. (F. '40). *Hesperiidae.*
'40. Benesh, Bernard, P. O. Box 159, North Chicago, Ill. *Lucanidae.*
Ch. Bentley, G. M., 64 Biology Bldg., Univ. of Tennessee, Knoxville 16, Tenn. *Orthoptera.*
'23. Benton, Curtis, 1216 Ball St., Lafayette, Ind.
'17. *BEQUAERT, JOSEPH C., Curator of Insects, Museum of Comparative Zoology, Cambridge, Mass. (F. '34.) *Vespidae, Tabanidae.*
'28. Berley, J. A., Div. of Ent., Clemson College, S. C. *Coccidae, Odonata.*
'43. Berner, Lewis, Dept. of Biology, Univ. of Florida, Gainesville, Fla.
'39. Berry, Paul A., American Consul, Montevideo, Uruguay. *Biological Control.*
'34. Bess, Henry A., 623 North Second St., Milwaukee 3, Wis. *Ecology, Forest Insects.*
Ch. BETTEN, CORNELIUS, 104 Corson Place, Ithaca, N. Y. (F. '37). *Trichoptera.*
'28. Bibby, F. F., Smithville, Miss. *Cicadidae.*

'38. *Bickley, William E., Jr., U. S. Public Health Service, 300 Essex Bldg., Norfolk 10, Va. *Chrysopidae.*
'25. Bigger, J. H., Natural Resources Bldg., Urbana, Ill. *Plant Resistance to Insect Attack.*
'30. Billings, Samuel C., 8407 Woodcliff Court, Silver Spring, Md. *Mothproofing.*
'13. BILSING, S. W., College Station, Texas. (F. '41). *Cerambycidae.*
Ch. BIRD, HENRY, 600 Milton Road, Rye, N. Y. (F. '30). *Noctuidae, Papaipema.*
Ch. BISHOPP, F. C., Bur. of Ent. and Plant Quar., Washington, D. C. (F. '28). *Ixodoidea, Siphonaptera, Anoplura.*
'24. BISHOPP, SHERMAN C., Dept. of Biology, Univ. of Rochester, Rochester, N. Y. (F. '43). *Arachnida.*
'25. Bissell, Theodore L., Experiment, Ga. *Aphididae, Curculionidae.*
'37. Blackburn, Norris D., Ohio Agric. Exp. Sta., Wooster, Ohio. *Chrysomelidae.*
Ch. BLAISDELL, F. E., 22 High St., Watsonville, Calif. (F. '24). *Tenebrionidae, Melyridae.*
'28. Blanchard, R. A., Box 32, Urbana, Ill. *Plant Resistance to Insect Attack.*
'32. Blanton, Franklin S., 3723 Holms Lane, Building 504, Parkfairfax, Alexandria, Va. *Trypetidae, Otitidae.*
'30. Blauvelt, Helen Hayden, care of William Savey, Lake Road, Ithaca, N. Y.
'28. Blauvelt, William E., Comstock Hall, Cornell Univ., Ithaca, N. Y.
'29. BOESEL, M. W., R. R. No. 2, Oxford, Ohio. (F. '43). *Chironomidae.*
'44. Bohart, George Edward, P. O. Box 213, Jacksonville, N. C.
'37. Bohart, Richard M., Division of Entomology, College of Agriculture, Davis, Calif. *Strepsiptera, Hymenoptera.*
'28. BORROR, DONALD J., Dept. of Zoology & Entomology, Ohio State Univ., Columbus 10, Ohio. (F. '43). *Odonata.*
'46. Boudreaux, H. Bruce, Dept. of Zoology, Louisiana State Univ., Box 8729, Baton Rouge 13, La. *Aphididae.*
'14. BOVING, ADAM G., U. S. National Museum, Washington 25, D. C. (F. '29, H. F. '41). *Coleopterous larvae.*
'42. Bowery, Thomas G., 214 Birmingham Ave., Avalon, Pittsburgh 2, Pa.
'33. Boyce, A. M., Citrus Exper. Sta., Riverside, Calif.
Ch. BRADLEY, J. C., Cornell Univ., Ithaca, N. Y. (F. '14). *Campsomeris, Vespidae, Scoliidae.*
'19. BRADLEY, G. H., Box 654, New Smyrna Beach, Fla. (F. '41). *Diptera, Culicidae.*
'37. Bradley, William G., 2256 Collingwood Ave., Toledo, Ohio. *Parasitic Hymenoptera.*
'23. Branch, Hazel E., Univ. of Wichita, Wichita 6, Kans. *Chironomidae Larvae.*
'25. Brandhorst, Carl T., 106 Lincoln St., Seward, Neb. *Wasps.*
Ch. BRAUN, ANNETTE F., R. R. No. 13, Box 41C, Cincinnati 30, Ohio. (F. '24). *Microlepidoptera.*
'26. BREAKEY, E. P., Western Washington Exper. Sta., Puyallup, Wash. (F. '43). *Cicadellidae.*
'37. Breland, Osmond P., Dept. of Zoology, Univ. of Texas, Austin, Texas. *Chalcidoidea.*
'29. Brindley, T. A., 822 East Eighth St., Moscow, Idaho. *Pea Weevil.*
'26. BRITTAIN, W. H., McDonald College P. O., Quebec, Canada. (F. '37). *Homoptera.*
'20. BROMLEY, STANLEY W., Scoffieldtoan Road, Stamford, Conn. (F. '37). *Asilidae.*
'40. Brookman, Bernard, 1728 N. W. 32nd Ave., Portland 10, Ore. *Diptera.*
'39. Brower, Auburn E., 5 Hospital St., Augusta, Me. *Lepidoptera, Catocala.*
'33. Brown, F. Martin, Fountain Valley School, Colorado Springs, Colo. (F. '44). *Pieridae of the Americas.*
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'28. CAMPBELL, FRANK LESLIE, The Scientific Monthly, Smithsonian Institution Bldg., Washington 25, D. C. (F. '34). *Toxicology.*
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'36. Harmston, Fred Carl, 117 East 27th South, Salt Lake City, Utah. *Dolichopodidae.*
'07. *Harned, R. W., Bur. of Ent. & Plant Quar., Washington 25, D. C. (F. '27).
'33. Harper, Lawrence C., R. R. No. 1, Lafayette, N. Y. *Diptera.*
'29. Harries, F. H., 151 West Eleventh Ave., Columbus, Ohio. (F. '43). *Ecology, Physiology.*
'23. Harris, Halbert M., Dept. of Zoology, Iowa State College, Ames, Iowa. (F. '37). *Hemiptera.*
'44. Harston, George B., Wyoming State Entomologist, P. O. Box 785, Powell, Wyoming.
'42. Hart, Thomas A., 5556 Kimbark Ave., Chicago, Ill.
'39. Hartnack, Hugo, 324 North Fourth St., Tacoma, Wash.
'21. Hartzell, Albert, Boyce Thompson Institute, 1086 North Broadway, Yonkers 3, N. Y. *Cicadellidae.*
'07. Hartzell, F. Z., Agric. Exper. Sta., Geneva, N. Y. *Coleoptera.*
Ch. Haseman, Leonard, Whitten Hall, Dept. of Entomology, Univ. of Missouri, Columbia, Mo. *Psychodidae.*
'32. Haskins, Caryl P., Green Acre Lane, Westport, Conn. (F. '44). *Formicidae, Hymenoptera.*
'20. Hatch, Melville H., Dept. of Zoology, Univ. of Washington, Seattle 5, Wash. (F. '38). *Coleoptera.*
'38. Hathaway, Edward S., Dept. of Zoology, Tulane Univ., New Orleans, La. *Ecology of Marsh Insects.*
'32. Haub, James G., Dept. of Zoology, Ohio State Univ., Columbus, Ohio. *Physiology.*
'39. Haude, William J., care of John Powell & Company, 1 Park Ave., New York, N. Y. *Culicidae.*
'30. Haug, Gordon W., Kelowna, British Columbia, Canada. *Formicidae.*
'27. Hawkins, J. H., Agric. Exper. Sta., Orono, Me. *Elaterid & Noctuid Larvae.*
'32. Hawley, I. M., P. O. Box 150, Moorestown, N. J. *Japanese Beetle.*
'35. Haydak, M. H., Div. of Entomology, University Farm, St. Paul 8, Minn. *Honeybee Nutrition.*
'19. Hayes, William P., Entomology Bldg., Univ. of Illinois, Urbana, Ill. (F. '29). *Larvae.*
'31. Heaton, Robert R., 518 Architects & Builders Bldg., Indianapolis 4, Ind. *Fulgoridae, Homoptera.*
'34. Hendee, Esther, (Mrs. Kottke), 4044 Warwick Ave., Chicago 41, Ill. *Isoptera, Hymenoptera.*
'32. Henderson, Charles, 803 Forty-third Ave., Gulfport, Miss. *Parasites of Scale Insects.*
'31. Henderson, Lyman S., Bur. of Ent. & Plant Quar., Beltsville Research Center, Beltsville, Md. (F. '43). *Curculionidae.*
'29. Hering, Paul E., Dept. of Biology, Carthage College, Carthage, Ill. *Economic Entomology.*
'25. Herms, William B., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. (F. '29). *Medical Entomology.*
Ch. Herrick, Glenn W., 219 Kelvin Place, Ithaca, N. Y. (F. '14). *Thysanoptera, Coccidae.*
'43. Hertig, Major Marshall, Sn.C., care of Headquarters P. C. D., APO 834, care of Postmaster, New Orleans, La.
'28. Hickman, J. R., Normal College, Ypsilanti, Mich. *Haliplidae.*
'08. Hilton, William A., 1263 Dartmouth Ave., Claremont, Calif. (F. '39). *Symphyla, Pauropoda.*
'27. Hinman, E. Harold, Health & Safety Dept., Tennessee Valley Authority, Wilson Dam, Ala. (F. '37). *Culicidae.*
'33. Hinton, Howard E., Dept. of Ent., British Museum (Natural History), Cromwell Road, London, S. W. 7, England. (F. '44). *Dryopidae.*
'27. Hockenyos, George L., 213 East Jefferson St., Springfield, Ill. *Economic Entomology.*
'38. Hodge, Charles 4th, Dept. of Biology, Temple Univ., Philadelphia, Pa. *Coleoptera.*
Ch. Hodgkiss, H. E., 147 West Park Ave., State College, Pa. *Eriophyiidae.*
'29. Hodson, A. C., Div. of Ent., Univ. Farm, St. Paul, Minn. (F. '43). *Ecology.*

'44. Hoff, C. Clayton, Dept. of Zoology, Colo. State College, Ft. Collins, Colo.
'43. Hoffmann, Anita, Apartado 8026, Mexico, D. F., Mexico.
'29. Hoffmann, Clarence H., Box 71, Bowie, Md. *Scarabaeidae.*
'20. HOFFMANN, WILLIAM E., Lingnan University, Canton, China. (F. '39). *Hemiptera.*
'35. Holway, Richard T., 9 Crescent St., Shrewsbury, Mass. *Termites.*
'38. Hoogstraal, Harry, 7815 South Park Ave., Chicago 19, Ill. *Morphology.*
'34. HORSFALL, WILLIAM R., Dept. of Entomology, Univ. of Arkansas, Fayetteville, Ark. (F. '43). *Culicidae.*
'34. Hoskins, W. M., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. *Physiology.*
'24. Hough, W. S., Winchester, Va. *Apple Insects.*
Ch. HOUSER, J. A., Agric. Exper. Sta., Wooster, Ohio. (F. '31). *Coccidae.*
'39. Hovey, Charles L., Box 728, Eastern States Farmers Exchange, Hedrick Bldg., West Springfield, Me. *Aphiidae.*
'44. Hovanitz, William, Univ. of Michigan, Laboratory of Vertebrate Biology, Ann Arbor, Mich.
Ch. HOWARD, L. O., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '07, H. F. '24). *Chalcidoidea.*
'14. HOWARD, NEALE F., 151 West Eleventh Ave., Columbus, Ohio. (F. '44). *Mexican Bean Beetle.*
'39. Howland, A. F., 1208 East Main St., Alhambra, Calif. *Tomato Insects.*
'23. HUBBELL, THEODORE H., Dept. of Biology, Univ. of Florida, Gainesville, Fla. (F. '39). *Orthoptera.*
'20. HUCKETT, H. C., Long Island Vegetable Research Farm, Riverhead, Long Island, N. Y. (F. '38). *Muscidae.*
'44. Huffaker, Carl B., 1050 San Pablo Ave., Albany 6, Calif. *Mecoptera.*
'39. Hughes, John H., U.S.P.H.S., Division of Foreign Quarantine, Washington 14, D. C. *Chrysomelidae.*
'16. HUNGERFORD, H. B., 323 Snow Hall, Univ. of Kansas, Lawrence, Kans. (F. '27). *Aquatic Hemiptera.*
'43. Hunt, Charles R., Dept. of Zoology, Washington State College, Pullman, Wash.
'36. Hurlbut, Herbert S., West High St., Union City, Pa. *Culicidae.*
'38. Hutson, Ray, Dept. of Entomology, Michigan State College, East Lansing, Mich. *Insecticides.*
'42. Hutzel, John M., 124 Moncure Drive, Alexandria, Va.
'08. HYSLOP, JAMES A., Arsenal, Silver Spring, Md., (F. '35). *Elateridae.*

I

'31. IDE, F. P., Dept. of Zoology, Univ. of Toronto, Toronto 5, Ontario, Canada. (F. '40). *Ephemeroptera.*
'19. *ILLINGWORTH, J. F., Bishop Museum, Honolulu, Hawaii. (F. '40). *Muscoidea.*
'28. Ingram, J. W., Box 387, Houma, La. *Sugarcane Insects.*
'14. ISELY, DWIGHT, Box 3, University Station, Fayetteville, Ark. (F. '34). *Chrysomelidae, Curculionidae.*
'36. ISELY, F. B., 2835 West Gramercy, San Antonio, Tex. (F. '46). *Orthoptera.*
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*
'34. Ivy, Edward E., Box 1218, Waco, Tex.

J

'41. James, Brother Cyprian, Manhattan College, Spuyten Duyvil Parkway, New York 63, N. Y. *Psyllidae.*
'38. James, Freburn L., 3934 SCU, CME, Loma Linda, Calif. *Coleoptera.*
'31. JAMES, MAURICE T., Dept. of Entomology, Colorado State College, Fort Collins, Colo. (F. '40). *Stratiomyiidae.*
'30. Janes, Melvin J., Office, Ninth Service Command Engineers, Fort Douglas, Utah. *Economic Entomology.*
'35. Jaques, Harry E., 709 North Main, Mount Pleasant, Iowa. *Insect Ecology.*
'30. Jaynes, H. A., 117 Chatham St., Chatham, N. Y. *Tiphia of S. A.*
'10. Jennings, H. R., High School of Com., Hayes & Van Ness Ave., San Francisco, Calif. *Diptera.*

'41. Jensen, Dilworth D., Univ. of Hawaii Agric. Exper. Sta., Honolulu, T. H. *Psyllidae.*
'15. Jewett, H. H., Agric. Exper. Sta., Lexington, Ky. *Tobacco and Foreign Crop Insects.*
'43. Jodka, Joseph F. T., Comstock Hall, Cornell Univ., Ithaca, N. Y.
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'46. Johnson, Donald Ross, 6409 Tahoma Ave., Chicago 30, Ill.
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'39. Johnson, John W., 1748½ Orange Ave., Costa Mesa, Calif. *Saturniidae.*
'27. Jones, Elmer T., 1204 Fremont, Manhattan, Kans. *Hessian Fly.*
Ch. JONES, FRANK M., 2000 Riverview Ave., Wilmington 47, Del. (F. '46). *Psychidae.*
'39. Jones, J. R. J. Llewellyn, "Arranmore," R. M. D. No. 1, Cobble Hill, British Columbia, Canada. *Ecology of Lepidoptera Larvae.*
'46. Jones, Jack D., Box 212, R. R. No. 1, Fort Collins, Colo. *Cicadidae.*
'41. Jones, Joseph W., Jr., Dept. of Zoology, Univ. of Tennessee, Knoxville, Tenn.
'45. Jones, Sarah Elizabeth, Dept. of Biology, Box 3716, Texas State College for Women, Denton, Tex.
'45. Joyce, Charles R., U.S.P.H.S., Quarantine Sta., Box 992, Brownsville, Tex.
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'40. Just, Theodore K., P. O. Box 126, Notre Dame, Ind.

K

'42. Kadner, Carl G., Loyola Univ., Los Angeles, Calif. *Hippoboscidae, Culicidae.*
'34. Kagy, J. Franklin, care of Dow Chemical Co., P. O. Box 245, Seal Beach, Calif. *Insect Toxicology.*
'26. Kamal, Mohammed, care of A. Moursi, Minister of Agriculture, Parasite Laboratory, Giza, Egypt. *Cotton Insects.*
'34. Kearns, Clyde W., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. *Insecticides.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii. *Ecology.*
'14. KENNEDY, C. H., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. (F. '27). *Odonata, Ants.*
Ch. Kincaid, Trevor, Univ. of Washington, Seattle, Wash. *Psychodidae, Dytiscidae.*
'12. KING, J. L., Box 150, Moorestown, N. J. (F. '32). *Biological Control.*
'23. KING, KENNETH M., Dominion Field Crop Insect Laboratory, Victoria, B. C. (F. '38). *Elateridae Larvae, Noctuidae.*
'28. KING, WILLARD V., Box 3391, Orlando, Fla. (F. '38). *Culicidae.*
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'38. Klots, Alexander B., Dept. of Biology, 17 Lexington Ave., New York, N. Y. *Lepidoptera.*
'45. Knapp, Virgil Robert, Zionsville, Ind.
'11. KNIGHT, H. H., Dept. of Zoology, Iowa State College, Ames, Iowa. (F. '28). *Hemiptera, Miridae.*
'40. Knight, Kenneth L., 4513 Gladwyne Drive, Bethesda 14, Md. *Geometrid Larvae.*
'24. KNOWLTON, GEORGE E., Utah State Agricultural College, Logan, Utah. (F. '40). *Aphididae.*
'32. KNULL, MRS. DOROTHY, 330 East Dunedin Road, Columbus 2, Ohio. (F. '43). *Cicadellidae, Cercopidae.*
'34. KNULL, JOSEF N., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. (F. '43). *Cleridae, Elateridae, Buprestidae, Cerambycidae.*
'37. Knutson, Herbert C., U.S.P.H.S., 605 Volunteer Bldg., 66 Luckie St., Atlanta, Ga. *Noctuidae.*
'34. Kottke, Mrs. Esther Hendee, 4044 Warwick Ave., Chicago 41, Ill.
'17. Kraatz, Walter C., Dept. of Biology, Univ. of Akron, Akron, Ohio.
'42. Krafchick, Bernard, 578 Greene Ave., Brooklyn, N. Y.
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'34. KROMBEIN, KARL VON VORSE, Div. of Insects, U. S. National Museum, Washington 25, D. C. (F. '44). *Aculeate Hymenoptera.*
'41. Kuitert, Louis C., Entomology Dept., Univ. of Kansas, Lawrence, Kans. *Nepidae, Gerridae.*
'36. Kulash, Walter M., Dept. of Zoology & Entomology, North Carolina State College, Raleigh, N. C. *Collembola.*

L

'45. Laffoon, Jean, 1401 West Third, Sioux City 17, Iowa.
'46. Laidlaw, Harry H., F. S. C. Laboratory, 281 South St., Jamaica Plain 30, Mass.
'28. Lamiman, J. F., 2244 Summer St., Berkeley 7, Calif. *Acarina.*
'30. LANDIS, B. J., P. O. Box 218, Union Gap, Wash. (F. '40). *Biological Control.*
'42. Lane, John, Instituto de Higiene de Sao Paulo, Caixa Postal 99B, Sao Paulo, Brazil.
'40. Lange, W. Harry, Jr., Div. of Entomology, Univ. of California, Davis, Calif. *Lepidoptera.*
'25. Langford, George S., Dept. of Entomology, Univ. of Maryland, College Park, Md. *Economic Entomology.*
'17. Langston, James M., State College, Miss. *Phyllophaga.*
'37. LaRivers, Ira, Box 1493, Reno, Nev. *Odonata, Psychodidae.*
'14. Larrimer, W. H., U. S. D. A., Forest Service, Washington, D. C. *Cicadellidae.*
'38. Larson, N. P., Box 674, Hulmeville, Pa. *Physiology.*
'37. Lassmann, G. W., Independencia No. 3, Jalapa, Vera Cruz, Mexico. *Culicidae.*
'13. LATHROP, F. H., Agric. Exper. Sta., Orono, Me. (F. '41). *Cicadellidae.*
'40. Latta, Randall, Bur. of Ent. & Plant Quar., Washington, D. C. *Toxicology.*
'23. Lauderdale, J. L. E., P. O. Box 2006, Phoenix, Ariz.
'17. LAWSON, PAUL B., 2215 Vermont St., Lawrence, Kans. (F. '31). *Cicadellidae.*
'39. Leech, H. B., P. O. Box 308, Vernon, British Columbia, Canada. *Coleoptera.*
'12. LEIBY, R. W., Comstock Hall, Cornell Univ., Ithaca, N. Y. (F. '40). *Embryology.*
'38. Leonard, Justin W., Institute for Fish Research, University Museums Annex, Ann Arbor, Mich. *Aquatic Insects.*
'11. LEONARD MORTIMER D., 2480 Sixteenth St. N. W., Washington, D. C. (F. '46). *Aphididae.*
'34. LeVeque, Norma, 2135 Fourth St., Boulder, Colo. *Apoidea.*
'45. Lewis, Mrs. Sue Sparks, 224 East High St., Lexington, Ky. *Ants.*
'33. Lilly, John H., King Hall, Univ. of Wisconsin, Madison 6, Wis. *Coleophoridae.*
'34. Lindgren, David L., Univ. of California, Citrus Exper. Sta., Riverside, Calif. *Toxicology.*
'39. Lindquist, Arthur W., Box 3391, Orlando, Fla. *Chironomidae.*
'46. Lindsay, Dale R., P. O. Box 932, Pharr, Texas. *Medical Entomology.*
'17. LINDSEY, A. W., Box 612, Granville, Ohio. (F. '40). *Hesperioidea.*
'33. *LINSLEY, E. GORTON, 112 Agricultural Hall, Univ. of California, Berkeley, Calif. (F. '41). *Cerambycidae, Coleoptera.*
'25. LIST, GEORGE M., Agricultural College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'30. Livingston, E. M., 4425 Bienville Ave., New Orleans, La.
'31. Lloyd, Llewellyn, University of Leeds, London, England.
'19. Lobdell, Mrs. Gladys H., Route 2, Brevard, N. C. *Coccidae.*
'46. Ludwig, Carl E., 19 Gates St., Manchester, N. Y.
'38. Ludwig, Daniel, Dept. of Biology, New York Univ., 181st St. and University Ave., New York 53, N. Y. *Physiology.*
'13. LUGINBILL, PHILIP, Box 495, Lafayette, Ind. (F. '41). *Phyllophaga.*
'34. Lund, Horace O., Div. of Biological Science, Univ. of Georgia, Athens, Ga. *Culicidae.*
'31. Lyle, Clay, Box 1538, State College, Miss. *Crustacea.*
'40. Lyman, F. Earle, U.S.P.H.S., P.H.S. 3472, 412 Hilldale Ave., Decatur, Ga. *Aquatic Insects, Ephemeroptera.*

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'40. MacSwain, J. W., P. O. Box 175, Loving, N. M.
'20. McBride, O. C., Box 340, Honolulu 9, Hawaii. *Insecticides.*
'43. McCall, George L., 1107 Juliette Ave., Manhattan, Kans.
'29. McClure, H. Elliott, Box 292, Station A, Bakersfield, Calif. *Ecology.*
'17. McCRACKEN, ISABEL, Box 1545, Stanford Univ., Calif. (F. '39). *Apoidea.*
'10. McDaniel, Eugenia, Agric. Coll., East Lansing, Mich. *Coccidae, Orthoptera.*
'30. McGovran, E. R., Bur. of Ent. & Plant Quar., Beltsville, Md. *Toxicology.*
'11. McINDOO, N. E., 7225 Blair Road, Takoma Park, Washington 12, D. C. (F. '34). *Insect Physiology.*
'32. Madden, A. H., Bur. of Ent. & Plant Quar., Box 3391, Orlando, Fla. *Economic Entomology.*
'43. Maina, Bartholomew A., 10623 Church St., Chicago, Ill.
'40. Mangrum, James F., Box 203 F. E., Biology Dept., A. & M. College, College Station, Texas. *Acarina.*
'13. *MANN, WILLIAM M., Natural Zoological Park, Washington, D. C. (F. '37). *Formicidae.*
'23. Manter, Jerauld A., Agric. College, Storrs, Conn. *Economic Entomology.*
'22. Marcovitch, S., University Farm, Knoxville, Tenn. *Insecticides.*
'37. Markos, Basil G., 17 Mechanic St., Dover, N. H. *Toxicology.*
Ch. MARLATT, C. L., 1521 Sixteenth St. N. W., Washington, D. C. (F. '07, H. F. '41). *Coccidae.*
Ch. MARSHALL, W. S., 139 East Gilman St., Madison 3, Wis. (F. '17). *Morphology.*
'25. Martin, Charles H., Dept. of Entomology, Oregon State College, Corvallis, Ore. *Ecology.*
'43. Martin, Esmond B., 465 East 57th St., New York 22, N. Y.
'34. MARTORELL, LUIS F., Agric. Exper. Sta., P. O. Box 614, Rio Piedras, Puerto Rico. (F. '44). *Sugar Cane, Forest Insects.*
'38. Marvin, Philip H., Hartford Road, Moorestown, N. J. *Biology of Melittobia.*
'21. Mason, Arthur C., Box 150, Moorestown, N. J. *Thysanoptera.*
'30. Mason, Horatio C., 151 West Eleventh Ave., Columbus, Ohio. *Tomato Fruitworm.*
'46. Mason, William R. M., 11537 97th St., Edmonton, Alberta, Canada.
Ch. MATHESON, ROBERT, Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Maxson, Asa C., P. O. Box 46, Longmont, Colo. *Aphidae.*
'36. Mead, Albert R., 1035 Franklin St., Santa Clara, Calif. *Chrysomelidae.*
'37. Medler, John T., Dept. of Ent., Univ. of Wisconsin, Madison, Wis. *Cicadellidae.*
'25. Meiners, Edwin, Room 238, 6651 Enright, St. Louis 5, Mo. *Lepidoptera.*
Ch. MELANDER, A. L., 4670 Rubidoux Drive, Riverside, Calif. (F. '14). *Diptera.*
'27. Melvin, Roy, Menard, Texas. *Physiology.*
'33. Menusan, Henry, Jr., 204 Agric. Education Bldg., State College, Pa. *Physiology, Ecology.*
'23. Merrill, G. B., Plant Board, Seagle Bldg., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. (F. '20). *Syrphidae.*
'39. Metcalf, Robert L., Citrus Exper. Sta., Univ. of California, Riverside, Calif. *Insect Physiology.*
'09. METCALF, Z. P., State College Sta., Box 5215, Raleigh, N. C. (F. '34). *Homoptera*
'35. MICHELBACHER, A. E., 112 Agricultural Hall, Univ. of California, Berkeley, Calif. (F. '41). *Symphyta, Apoidea.*
'37. MICHENER, CHARLES D., American Museum of Natural History, 79th Street and Central Park West, New York, N. Y. (F. '44). *Apoidea.*
'17. MICKEL, CLARENCE E., Div. of Entomology, University Farm, St. Paul, Minn. (F. '35). *Mutillidae.*
'36. Miller, Albert, Dept. of Tropical Medicine, Tulane Univ., New Orleans 13, La. *Culicidae.*

'31. Miller, Albert C., Box 2038, Pittsburgh 30, Pa. *Membracidae.*
'42. Miller, E. Morton, Dept. of Zoology, Box 452, Univ. of Miami, Coral Gables 34, Fla.
'46. Miller, Ralph H., 581 Euclid Ave., Apt. 5, Upland, Calif.
'37. Milliron, Herbert E., 354 South Grant St., W. Lafayette, Ind.
'29. MILLS, HARLOW B., Dept. of Entomology, Montana State College, Bozeman, Mont. (F. '37). *Collembola.*
'37. Milne, Lorus J., Johnson Foundation, Univ. of Pennsylvania, Philadelphia 4, Pa. *Trichoptera.*
'25. Milum, Vern G., 104 Vivarium Bldg., Univ. of Illinois, Champaign, Ill. *Apiculture.*
'43. el Minchaoui, Ibrahim, care of Societe Generale des Sucreries et de la Raffinerie d' Egypte, P. O. B. 763, Cairo, Egypt.
'26. MINNICH, D. E., Dept. of Zoology, Univ. of Minnesota, Minneapolis, Minn. (F. '39). *Behavior.*
'38. Miroyiannis, Stanley D., Dept. of Biology, Northeastern Univ., Boston, Mass. *Histology.*
'39. Mitchell, Robert T., Patuxent Research Refuge, Bowie, Md. *Ichneumonidae & Braconidae.*
'21. MITCHELL, T. B., State College, Raleigh, N. C. (F. '37). *Apoidea, Megachile.*
'22. MONTGOMERY, B. ELWOOD, Dept. of Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'39. Moore, G. A., 359 Querbes Ave., Outremont, Quebec, Canada. *Hemiptera.*
'39. Moore, Warren, Bon Air, Va. *Dermestidae.*
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Ch. MORRILL, A. W., 1327 Alameda Ave., Glendale 1, Calif. (F. '39).
'12. MORRISON, HAROLD, Bur. of Ent. & Plant Quar., Washington, D. C. (F. '28). *Coccidae.*
'08. MOSHER, EDNA, R. R. No. 1, Newport, Nova Scotia, Canada. (F. '20). *Lepidoptera.*
'20. Mote, Don C., State Agric. College, Corvallis, Ore. *Economic Entomology.*
'29. MOULTON, DUDLEY, 35 Elwood St., Redwood City, Calif. (F. '31). *Thysanoptera.*
'15. MUESEBECK, C. F. W., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '34). *Braconidae, Bethylidae.*
'36. Mulrennan, J. A., State Board of Health, Box 210, Jacksonville, Fla. *Culicidae.*
'43. Muma, Martin H., Dept. of Ent., Univ. of Nebraska, Lincoln, Neb.
'27. *Munro, J. A., State College Sta., Fargo, N. D. *Orthoptera, Diptera.*
'37. Munson, Sam C., Bur. of Ent. & Plant Quar., Beltsville, Md.
'35. *Murray, William D., 4460 Rosemary Parkway, Columbus 2, Ohio. *Sphecidae.*
'28. MUSGRAVE, ANTHONY, Australian Museum, College St., Sydney, New South Wales, Australia. (F. '41). *Nycteribiidae.*
'27. Musgrave, Paul N., 1956 Underwood Ave., Huntington, W. Va. *Dryopidae.*

N

'35. Nagel, R. H., Forest Insect Investigations, Agric. Research Center, Beltsville, Md.
'46. Nakajima, Toshio, Entomological Institute, Fac. of Agr. Hokkaido, Sapporo, Imperial Univ., Japan. *Scarabaeidae.*
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07, H. F. '35.) *Odonata, Ephemerida.*
'21. Neiswander, C. R., Ohio Agric. Exper. Sta., Wooster, Ohio. *Insects of Ornamentals.*
'28. Neiswander, R. B., Agric. Exper. Sta., Wooster, Ohio. *Fruit Insects.*
'39. Nesbitt, Herbert H. J., 34 Lakeside Ave., Ottawa, Ontario, Canada. *Acarina.*
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa. *Economic Entomology.*
'34. Nevin, F. Reese, Rider College, Trenton, N. J. *Morphology of Acarina.*
Ch. Newcomer, E. J., Box 1291, Yakima, Wash. *Fruit Insects.*
'15. Newman, George B., 246 East Hamilton Ave., State College, Pa. *Insect Histology.*
'28. Newton, Richard C., Bur. of Ent. & Plant Quar., Bozeman, Mont. *Alfalfa Weevil.*

'38. Nicholson, H. Page, U.S.P.H.S., Carter Memorial Lab., Box 547, Savannah, Ga. *Simuliidae.*
'31. Nickels, C. B., Box 209, Bur. of Ent., Brownwood, Tex. *Pecan Insects.*
'22. Noble, W. B., Bur. of Ent. & Plant Quar., Box 1857, Sacramento 9, Calif. *Hessian Fly.*
'38. Noland, Lowell E., Biology Bldg., Univ. of Wisconsin, Madison, Wis.
'17. *Notman, Howard, Circle Road, Dougan Hills, Staten Island, N. Y. *Carabidae, Staphylinidae.*
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'37. Nye, William P., Dept. of Ent., Room 225, Utah State Agric. College, Logan, Utah. *Forest Insects.*

O

'31. O'Byrne, Harold I., R. F. D. No. 1, Box 792, Glencoe, Mo. *Ecology Lepidoptera.*
'44. Ogloblin, Alexander, 3120 Sanabria, Buenos Aires, Argentina.
'08. O'KANE, WALTER C., Durham, N. H. (F. '24).
'29. OMAN, PAUL W., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '40). *Homoptera.*
'37. O'Neill, William J., Tree Fruit Branch Exper. Sta., Box 596, Wenatchee, Wash. *Fruit Insects.*
'34. Oosthuizen, M. J., School of Agriculture, Potchefstroom, South Africa. *Stored Grain Insects.*
Ch. OSBORN, HERBERT, Ohio State Univ., Columbus, Ohio. (F. '07, H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., 1 Highland Ave., Los Gatos, Calif. *Cicadellidae.*
Ch. OSBURN, R. C., Ohio State Univ., Columbus, Ohio. (F. '17). *Syrphidae.*
'43. Osmun, John V., Medical Branch, Headquarters 2nd Service Command, Governors Island, New York, N. Y.
'45. Owsley, William B., Kentucky Wesleyan Coll., Winchester, Ky.
'36. Owen, William Bert, Dept. of Zoology, Univ. of Wyoming, Laramie, Wyo. *Culicidae.*
'25. OZBURN, REG. H., Ontario Agric. Coll., Guelph, Ontario, Canada. (F. '43). *Insect Histology.*

P

'15. Packard, Clyde M., Bur. of Ent. & Plant Quar., Washington, D. C. *Cereal and Forage Insects.*
'18. Painter, H. R., 705 Bexley Road, West Lafayette, Ind. *Phyllophaga.*
'19. PAINTER, R. H., Dept. of Ent., Kansas State College, Manhattan, Kans. (F. '35). *Diptera, Bombyliidae.*
'39. Palm, Charles E., Dept. of Ent., Cornell Univ., Ithaca, N. Y. *Forage Crop Insects.*
'37. Palmer, Boyd B., Polytechnic Inst., San German, Puerto Rico. *Trichoptera.*
'27. PALMER, MIRIAM A., 621 South Howes St., Fort Collins, Colo. (F. '37). *Aphidae.*
'27. PARK, ORLANDO, Dept. of Zoology, Northwestern Univ., Evanston, Ill. (F. '40). *Pselaphidae.*
'39. Parker, Barbara M., Miner Laboratories, 9 South Clinton St., Chicago, Ill.
'25. PARKER, H. L., South American Parasite Lab., Blanca del Tabaré, 2950, Montevideo, Uruguay. (F. '40). *Parasitic Hymenoptera.*
'37. Parker, J. R., Bur. of Ent. & Plant Quar., Bozeman, Mont. *Orthoptera.*
'24. Parker, R. L., Dept. of Ent., Kansas State College, Manhattan, Kans. *Apiculture.*
'18. Parks, T. H., Dept. of Ent., Ohio State Univ., Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Tex. *Diptera.*
'43. Parr, Thaddeus, Whitemarsh Research Lab., Box 4388, Chestnut Hill P. O., Philadelphia 18, Pa.
Ch. PARROTT, P. J., Agric. Exp. Sta., Geneva, N. Y. (F. '14).
'12. PARSHLEY, H. M., Dept. of Zoology, Smith College, Northampton, Mass. (F. '43). *Heteroptera.*
'32. Parsons, Carl T., 238 East 62nd St., New York, N. Y.

'34. Parten, Herbert H., Div. of Ent., Univ. Farm, St. Paul, Minn. *Greenhouse Insects.*
'32. Passos, Cyril F. dos, Washington Corners, Mendham, N. J. *Lepidoptera.*
Ch. *PATCH, EDITH M., P. O. Box 150, Orono, Me. (F. '14). *Aphididae.*
'35. Paullus, Harold J., Midwest Div., California Packing Corp., Rochelle, Ill.
'23. *PAYNE, NELLIE M., care of American Cyanamid Co., Boston Post Road, Stamford, Conn. (F. '40). *Physiology.*
'20. PEAIRS, L. M., Morgantown, W. Va. (F. '40).
'34. Pechuman, La Verne L., 7 Davison Road, Lockport, N. Y. *Tabanidae.*
'40. Pederson, Calvin E., Dept. of Ent., Michigan State College, East Lansing, Mich.
'37. Pelton, John Z., 205 First Ave., Waverly, Ohio. *Aquatic Insects.*
'35. Penner, Lawrence R., Dept. of Zoology, Univ. of Connecticut, Storrs, Conn. *Araeopidae.*
'30. Pepper, Bailey B., Dept. of Ent., Agric. Exp. Station, New Brunswick, N. J. *Biological Control.*
'29. Peters, Harold T., State Teachers College, Bemidji, Minn. *Siphonaptera.*
'39. Peterson, Allan G., State Board of Health, Jackson 113, Miss. *Potato Insects.*
'11. PETERSON, ALVAH, Dept. of Ent., Ohio State Univ., Columbus, Ohio. (F. '28). *Biological Control.*
'37. Peterson, Lloyd O. T., Indian Head, Saskatchewan, Canada. *Forest Entomology.*
'40. Pettit, Lincoln C., 65 Grant St., Lockport, N. Y. *Dermestidae.*
Ch. PETTIT, R. H., Dept. of Ent., Michigan State College, East Lansing, Mich. (F. '39). *Coccidae.*
'07. PETRUNKEVITCH, ALEXANDER, Yale Univ., New Haven, Conn., (F. '37). *Arachnida.*
'43. Pfadt, Robert E., Dept. of Ent., Univ. of Wyoming, Laramie, Wyo.
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'12. Phillips, W. J., 718 Cargill Lane, Charlottesville, Va. *Harmolita.*
'37. Phillips, W. Levi, 985 South Third St., East Salt Lake City 4, Utah. *Lepidoptera.*
'44. Picard, Jean-Paul, 58-rue, St. Ambroise, Loretteville, Quebec, Canada.
Ch. PIERCE, W. DWIGHT, 1074 Browning Boulevard, Los Angeles 37, Calif. (F. '30). *Rhynchophora.*
'41. Platt, Fred R., Deputy Agric. Commissioner, Court House, Riverside, Calif. *Coccidae, Coleoptera.*
'41. Pletsch, Don, Dept. of Ent., Montana State College, Bozeman, Mont. *Psyllidae, Myrmeleonidae.*
'28. PLUMMER, C. C., Apartado Number 3, Colonia Anahuac, Mexico, D. F., Mexico. (F. '44). *Membracidae.*
'18. POOS, FRED W., Beltsville Research Center, Beltsville, Md. (F. '43).
'23. Porter, B. A., Bur. of Ent. & Plant Quar., Washington, D. C. *Fruit Insects.*
'43. Porter, John E., U. S. Quar. Sta., P. O. Drawer 1246, Miami Beach 39, Fla.
'44. Potts, Robert W. L., Room 6, Agric. Bldg., Embarcadero at Mission, San Francisco 5, Calif. *Scarabaeidae, Acraeinae.*
'26. Potts, Samuel F., 56 Hillhouse Ave., New Haven, Conn. *Toxicology, Physiology.*
'36. *Pratt, Harry D., U. S. Public Health Service, District No. 6, San Juan, Puerto Rico. *Ichneumonidae.*
'16. Price, W. A., Univ. of Kentucky, Lexington, Ky. *Economic Entomology.*
'32. *PRITCHARD, A. EARL, Malaria Control in War Areas, P. O. Box 210, Jacksonville 1, Fla. (F. '43). *Asilidae, Itonididae.*
'40. Pritchett, John C., 22 Federal Office Bldg., Seattle 4, Wash. *Quarantine Entomology.*
'28. PROCTER, WILLIAM, Bar Harbor, Me. (F. '40). *Insects of Mt. Desert Region.*
'33. Putman, W. L., Dominion Ent. Lab., Vineland Sta., Ontario, Canada. *Chrysopidae.*

Q

'36. Quarterman, Kenneth D., P. O. Box 789, Panama City, Fla. *Cimicidae.*

R

'44. Ramos, J. A., Dept. of Biology, Univ. of Puerto Rico, Mayaquez, Puerto Rico.
'42. Ramsay, Maynard J., Box 89, Route 11, St. Paul 7, Minn.
'43. Rapp, William F., Jr., 203 East Green St., Champaign, Ill.
'14. RAU, PHIL, 549 East Argonne Drive 22, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'23. READIO, PHILIP A., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '37). *Reduviidae.*
'44. Redd, Jabus Constantine, Box 1538, State College, Miss.
'23. Reed, W. D., Office of the Chief Engineer, New War Department Bldg., Room 5020, Washington, D. C. *Tobacco Insects.*
'30. Rees, Don M., Univ. of Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Joseph A., 530 Federal Bldg., Buffalo 3, N. Y. *Chrysomelidae, Fulgoridae.*
'44. Reeves, William C., Hooper Fouudation for Medical Research, San Francisco 22, Calif.
Ch. REHN, J. A. G., Academy of Natural Sciences, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'45. Reichart, Charles V., Dept. of Zoology and Entomology, Ohio State Univ., Columbus 10, Ohio.
'43. Remington, Charles L., Biological Laboratory, Harvard Univ., Cambridge, Mass.
'34. Rice, Paul L., Dept. of Ent., Agric. Exp. Sta., Newark, Del. *Chalcidoidea.*
'30. RICHARDS, A. GLENN, JR., Ent. Dept., Univ. Farm, St. Paul 8, Minn. (F. '38). *Noctuidae.*
'14. RICHARDSON, CHARLES H., Dept. of Ent., Iowa State College, Ames, Iowa. (F. '31). *Physiology.*
'29. RICHARDSON, MAJ. H. H., U. S. D. A. Quarantine Inspection Sta., 209 River St., Hoboken, N. J. (F. '41). *Physiology.*
'28. Richmond, Edward A., 31 Rosemont Ave., Frederick, Md. *Hydrophilidae.*
'46. Ricker, William E., Dept. of Zoology, Indiana Univ., Bloomington, Ind. *Plecoptera.*
'39. Riedel, F. A., 2894 Dexter St., Denver 7, Colo.
'43. Rieder, Robert E., Extension Ent. & Plant Pathologist, Oregon State College, Corvallis, Ore.
'39. Riegel, Garland T., Dept. of Entomology, Univ. of Illinois, Urbana, Ill. *Braconidae.*
'22. Ries, Donald T., Box 6, Utica, Ill. *Cephidae, Siricidae.*
'40. Riherd, Paul T., Box 1936, Nogales, Ariz. *Culicidae.*
'29. Riley, Merrill K., Box 38, Kaneohe, T. H. *Coccidae.*
Ch. RILEY, WILLIAM A., Dept. of Zoology, Univ. of Minnesota, Minneapolis, Minn. (F. '14). *Parasitology.*
'39. Rings, Roy W., 1158 Oakland Ave., Columbus, Ohio. *Cerambycidae.*
'33. RITCHER, PAUL O., Agric. Exp. Sta., Lexington, Ky. (F. '44). *Phyllophaga.*
'36. Ritchie, C. L., c/o Richard Saxon, Box 340, Honolulu 9, Hawaii.
'25. RIVNAY, EZEKIEL, Agric. Exp. Sta., Rehoboth, Palestine.
'39. Roark, R. C., Bur. of Ent. & Plant Quar., Beltsville, Md. *Insecticides.*
'40. Roberts, H. Radclyffe, Villa Nova, Pa. *Acrididae.*
'31. Roberts, J. Harvey, Box 8729, University, La. *Trichoptera.*
'43. Roberts, Reed S., 346 West First North, Logan, Utah.
'45. Robinson, John H., 715 Moret Plaza, Grand Prairie, Tex.
'15. Robinson, J. M., Box 671, Auburn, Ala.
'45. Robinson, Paul Francis, 21 Fenwood Road, Boston 15, Mass.
'26. ROBINSON, WILLIAM, Burnt Mills Hills, Silver Spring, Md. (F. '39). *Physiology.*
'41. Rockstein, Morris, Div. of Ent., Univ. of Minnesota, University Farm, St. Paul, Minn.
'13. Rockwood, L. P., Forest Grove, Ore. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. of Colorado Museum, Boulder, Colo. *Nomada.*
'44. Rodock, Roy Edgar, Lewiston State Normal School, Lewiston, Idaho.
'15. ROGERS, J. SPRED, 310 College Court, Gainesville, Fla. (F. '43). *Tipulidae.*

'41. *Rogoff, William M., 62 Hobson St., East Haven, Conn.
'27. ROHWER, S. A., Bur. of Ent. & Plant Quar., Washington, D. C. (F. '29). *Hymenoptera.*
'25. Rosewall, O. W., Box 8729, Dept. of Ent., Louisiana State Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'39. Ross, Edward S., Dept. of Ent., California Academy of Sciences, Golden Gate Park, San Francisco, Calif. *Histeridae, Embioptera.*
'31. Ross, HERBERT H., Natural History Survey, Urbana, Ill. (F. '37). *Sawflies, Caddis Flies.*
'12. Ross, William A., Vineland Sta., Ontario, Canada. *Aphidae.*
'40. Roth, Louis M., Dept. of Zoology, Ohio State Univ., Columbus 10, Ohio. *Diptera, Culicidae.*
'36. ROZEBOOM, LLOYD EUGENE, School of Hygiene & Public Health, 615 North Wolf St., Baltimore, Md. (F. '46). *Culicidae.*
'14. Ruckes, Herbert, 167–11 33rd Ave., Flushing, New York, N. Y. *Pentatomidae.*
'39. Rude, Clifford S., Box 96, Menard, Tex. *Ixodidae.*
Ch. RUGGLES, A. G., University Farm, St. Paul, Minn. (F. '35).
'46. Russell, Louise M., Bur. of Ent. & Plant Quar., Washington, D. C.
'42. Ryan, George S., care of C. H. Elliott, Angola, Ind.

S

'33. *SABROSKY, CURTIS W., Div. of Insects, U. S. National Museum, Washington, D. C. (F. '41). *Chloropidae.*
'41. Sailer, Reece I., Div. of Insects, U. S. National Museum, Washington, D. C. *Hemiptera.*
'38. Sailsbury, Murl B., 824 Gaffield Place, Evanston, Ill. *Chrysomelid Larvae.*
'46. Sakagami, Shoichi, Entomological Institute, Hokkaido, Imperial Univ., Sapporo, Hokkaido, Japan.
'29. Sakimura, Kay, Pineapple Research Institute, Box 3166, Honolulu 2, Hawaii. *Thysanoptera.*
'46. Sallee, Roy M., 131 North Normal St., Macomb, Ill.
'37. Sampson, William W., 156 South Fourteenth St., Richmond, Calif. *Aphididae, Aleurodidae.*
'31. SANDERSON, MILTON W., Natural History Survey, Urbana, Ill. (F. '43). *Coleoptera.*
'07. SATTERTHWAIT, A. F., 806 Ohio St., Urbana, Ill. (F. '30). *Calendra.*
'46. Sawamoto, Takahisa, Hokkaido Forest Exp. Sta., Toyohira 5 jo 13 chome, Sapporo, Japan. *Scolytidae, Scolytoplatopidae, Platypodidae.*
'29. Scaramuzza, L. C., Central Mercedes, Prov. of Matanzas, Cuba. *Sugar Cane Insects.*
'30. Schlosberg, Morris, P. O. Box 606, West Lafayette, Ind. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii. *Ecology.*
'33. Schmidt, Helen D. O'Neil, Box 3166, Honolulu, Hawaii. *Trichoptera.*
'20. Schmieder, Rudolf G., Zoology Lab., Univ. of Pennsylvania, Philadelphia, Pa.
'32. SCHMITT, JOHN B., Dept. of Ent., N. J. Agric. Exp. Sta., New Brunswick, N. J. (F. '43). *Morphology.*
'34. Schmitt, T. J., Jr., Apt. 16, 1086 Corona St., Denver 3, Colo. *Scolytidae.*
'44. Schnitzer, Robert C.
Ch. SCHOENE, W. J., Agric. Exp. Sta., Blacksburg, V. (F. '44).
'36. Schoof, Herbert F., 302 Horne St., Raleigh, N. C. *Chrysomelidae.*
'29. Schroeder, H. O., 5601 Patrick Henry Drive, Baltimore, Md. *Ixodoidea, Argasidae.*
'37. Schroeder, Philip M., 2521 Irving Ave. South, Minneapolis, Minn. *Forest Insects.*
'40. Schuh, Joe, Box 101, Gresham, Ore. *Odonata.*
'26. SCHWARDT, H. H., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '35). *Tabanidae.*
'26. SCHWARZ, HERBERT F., American Museum of Natural History, 77th St. & Central Park West, New York, N. Y. (F. '37). *Meliponidae.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Lemna Insects.*

'25. SCULLEN, H. A., Dept. of Ent., Oregon State College, Corvallis, Ore. (F. '40). *Cerceridae.*
'46. Seabrook, Edwin L., County Courthouse Annex, West Palm Beach, Fla.
'23. Seamans, H. L., 616 Confederation Bldg., Ottawa, Ontario, Canada. *Muscoidea.*
'41. Sears, Jack W., B. L. 319, Univ. of Texas, Austin 21, Tex.
'36. Seevers, Charles, Roosevelt College of Chicago, 231 South Wells St., Chicago 4, Ill. *Termitophiles.*
'38. Semans, Frank M., North Jackson, Ohio. *Insect Control.*
'08. SEVERIN, H. C., South Dakota State College, Brookings, S. D. (F. '39). *Orthoptera, Homoptera, Heteroptera.*
'07. SHAFER, GEORGE D., 321 Melville Ave., Palo Alto, Calif. (F. '41). *Physiology.*
'46. Sharp, S. S., Dept. of Zoology & Entomology, Iowa State College, Ames, Iowa. *Toxicology.*
'35. Shaw, Frank R., Fernald Hall, Massachusetts State College, Amherst, Mass. *Mycetophilidae.*
'29. Shaw, John G., Laboratorio Entomologico, Apt. Number 3, Colonia Anhuac, D. F., Mexico.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'43. Shenefelt, Roy D., Zoology Dept., Washington State College, Pullman, Wash.
'22. SHEPARD, HAROLD H., Insecticide Testing Laboratory, Production & Marketing Adm., Beltsville, Md. (F. '39). *Hesperiidae.*
'17. Sherman, Franklin, Div. of Ent., Clemson College, S. C. *Acrididae, Cerambycidae, Cicindelidae.*
'11. SHERMAN, JOHN D., JR., 312 Primrose Ave., Mt. Vernon, N. Y. (F. '39). *Dytiscidae.*
'34. Shields, S. E., Grand River, Iowa. *Culicidae.*
'35. *Shockley, Wilfred, 1180 Sherman St., Denver 3, Colo. *Cerambycidae, Decticinae.*
'28. Shropshire, Leslie H., care of Fairmont Packing Co., Fairmont, Minn. *Economic Entomology.*
Ch. SHULL, A. FRANKLIN, 431 Highland Road, Ann Arbor, Mich. (F. '39). *Aphididae.*
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'32. Silvey, J. K. Gwynn, Dept. of Biology, North Texas State Teacher's College, Denton, Tex. *Coleoptera.*
'42. Simmonds, Frederick J., Imperial Parasite Service, Belleville, Ontario, Canada.
'29. Simmons, Perez, 712 Elizabeth St., Fresno 3, Calif. *Dried Fruit Insects.*
'39. Simonds, William E., Gridmoor Ojai, Calif. *Elateridae.*
'30. *Simpson, Geddes W., Holmes Hall, Orono, Me. *Insects and Plant Diseases.*
'38. Singleton, J. M., 209 River St., Hoboken, N. J. *Quarantines.*
'43. Slifer, Eleanor H., Dept. of Zoology, State Univ. of Iowa, Iowa City, Iowa.
'32. Smith, Carroll N., P. O. Box 78, Savannah, Ga. *Ixodidae.*
'32. Smith, Charles E., Agric. Exp. Sta., University Branch, Baton Rouge, La. *Truck Crop Insects.*
'35. SMITH, CLYDE F., Dept. of Ent., Univ. of North Carolina, Raleigh, N. C. (F. '46). *Aphididae.*
'27. SMITH, FLOYD F., Research Center, Beltsville, Md. (F. '43).
'35. Smith, Howard W., Nesmith Hall, Durham, N. H.
'37. Smith, Marion E., Fernald Hall, Massachusetts State College, Amherst, Mass. *Arctiidae.*
'19. SMITH, MARION R., Room 377, U. S. National Museum, Washington, D. C. (F. '38). *Formicidae.*
'42. Smith, Ray F., 112 Agriculture Hall, Univ. of California, Berkeley, Calif. *Diabrotica.*
'14. SMITH, ROGER C., Dept. of Ent., Kansas State College, Manhattan, Kans. (F. '31). *Neuroptera.*
'38. Smith, Septima C., Box 1446, University, Ala. *Odonata.*
'44. Smith, William Ward, U.S.P.H.S., Malaria Control in War Areas, Jackson 113, Miss.

'18. Snapp, Oliver I., Box 527, Fort Valley, Ga. *Rhynchophora.*
'39. Snipes, B. Thomas, Office of State Entomologist, State Dept. of Agric., Powell, Wyo. *Siphonaptera.*
'24. SNODGRASS, R. E., 3706 Thirteenth St., N. W., Washington, D. C. (F. '27). *Morphology.*
'45. Snow, Willis E., Dept. of Ent., Univ. of Illinois, Urbana, Ill.
'44. Snyder, Everett G., 1739 Gerrard Ave., Columbus 8, Ohio.
'36. Snyder, Fred M., 721 Oak Ave., Orlando, Fla. *Muscoidea.*
'38. Sommerman, Kathryn M., Box 53, Mt. Carmel, Conn. *Corrodentia.*
'26. Sorenson, Charles J,. Agric. Exp. Sta., Logan, Utah. *Miridae.*
'43. Sparks, Sue, (Mrs. W. M. Lewis), 224 East High St., Lexington, Ky.
'14. *Spencer, G. J., Univ. of British Columbia, Vancouver, British Columbia, Canada. *Trypetidae.*
'19. SPENCER, HERBERT, Box112, Fort Pierce, Fla. (F. '37). *Hymenoptera.*
Ch. SPOONER, CHARLES S., 1436 Seventh St., Charleston, Ill. (F. '43). *Fulgoridae.*
'39. Stafford, Eugene M., Univ. of California, Davis, Calif. *Vegetable Insects.*
'10. STAFFORD, E. W., State College, Miss. (F. '43). *Mallophaga.*
'38. Stains, George S., Dept. of Ent., Utah State College, Logan, Utah. *Conopidae, Simuliidae.*
'30. Stanford, J. S., Agric. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agric. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'35. Stehr, William C., Dept. of Biology, Ohio University, Athens, Ohio. *Coccinellidae, Carabidae.*
'27. Steiner, L. F., 1237 Washington Ave., Vincennes, Ind. *Fruit Insects.*
'46. Steinhaus, Edward A., Insect Pathology Lab., Univ. of California, Berkeley 4, Calif.
'29. Steinweden, John B., Bur. of Nursery Service, State Dept. of Agric., Sacramento, Calif. *Coccidae, Thysanoptera.*
'31. STEWART, M. A., Div. of Ent., 112 Agric. Hall, Univ. of California, Berkeley, Calif. (F. '41). *Siphonaptera.*
'15. Stiles, Charles F., Box 29, Stillwater, Okla.
'38. Stitt, Loyd L., 321 Seventh Ave., N. W., Puyallup, Wash. *Miridae.*
'27. STONE, ALAN, Bur. of Ent. & Plant Quar., Washington 25, D. C. (F. '40). *Simuliidae, Tabanidae.*
'36. Stone, Philip C., 105 Whitten Hall, Univ. of Missouri, Columbia, Mo. *Ixodidae.*
'28. Stone, William E., Laboratorio Entomologica, Apartado Number 3, Colonia Anahuac, D. F., Mexico.
'42. Strandtmann, R. W., Dept. of Preventive Medicine, Medical Branch, Univ. of Texas, Galveston, Tex. *Sphecidae.*
'12. Strickland, E. H., Main Library, Univ. of Alberta, Edmonton, Alberta, Canada. *Elateridae.*
'25. Strohecker, H. F., New Mexico Highlands Univ., Las Vegas, N. M.
'34. Strom, Lawrence G., 604 A. South 28th St., Milwaukee, Wis. *Aphiidae.*
'31. Summerour, A. R., Box 173, Lucedale, Miss.
'23. SWEETMAN, HARVEY L., State College, Amherst, Mass. (F. '43). *Ecology.*
'20. SWEZEY, OTTO H., 2044 Lanihuli Drive, Honolulu 5, Hawaii. (F. '30). *Delphacidae.*
'44. Swift, Hewson H., 85 Bedford St., New York, N. Y. *Araneida, Ichneumonidae.*

T

'46. Takahasi, Hirosi, Ent. Institute, Hokkaido Imperial Univ., Sapporo, Japan. *Simuliidae and Tabanidae.*
'37. Talbot, Mary, Lindenwood College, St. Charles, Mo. *Formicidae.*
'36. Tanner, M. C., 2902 Jackson Ave., Ogden, Utah. *Plecoptera.*
'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
'40. Tarshis, Irvin, 854 Steele St., Denver 6, Colo.
'31. Tate, Dr. H. D., Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn. *Ixodidae.*

'36. *Tauber, Oscar E., Dept. of Zoology, Iowa State College, Ames, Iowa. *Physiology.*
'22. Taylor, Leland H., Dept. of Botany, West Virginia University, Morgantown, W. Va. *Bees, Wasps.*
'34. *Telford, Horace S., Research Laboratories, Dr. Hess & Clark, Inc., Ashland, Ohio. *Syrphidae.*
'40. Thatcher, Theodore O., care of J. Karl Wood, River Heights, Logan, Utah. *Scolytidae, Buprestidae, Cerambycidae.*
'21. Thomas, Charles A., State College Lab., Kenneth Square, Chester County, Pa. *Elateridae, Scarabaeidae.*
'32. Thomas, Edward S., Ohio State Museum, Ohio State Univ., Columbus 10, Ohio. *Orthoptera.*
'38. Thomas, Henry D., North Park College, Foster & Kedzie, Chicago 25, Ill.
'15. Thomas, F. L., Agric. Exp. Sta., College Station, Tex. *Cotton Insects.*
'39. Thompson, W. L., Box 1074, Lake Alfred, Fla. *Citrus Insects.*
'10. THOMPSON, W. R., 228 Dundas St., Belleville, Ontario, Canada. (F. '27). *Tachinidae.*
'22. Tietz, Harrison M., Dept. of Zoology, Pennsylvania State College, State College, Pa. *Noctuidae.*
'11. TIMBERLAKE, P. H., Citrus Exp. Sta., Riverside, Calif. (F. '38). *Encyrtidae.*
'23. Tissot, A. N., Agric. Exp. Sta., Gainesville, Fla. *Aphididae.*
'26. Todd, F. E., care of Bee Culture, Beltsville, Md. *Apiculture.*
'33. *TOWNES, HENRY K., JR., 24 Lincoln Ave., Takoma Park, Md. (F. '43). *Ichneumonidae, Chironomus.*
'28. Townsend, Lee H., Dept. of Ent., Univ. of Kentucky, Lexington, Ky. *Neuroptera.*
'36. Trager, William, Rockefeller Institute, Princeton, N. J. *Insect Nutrition.*
'39. Traub, Robert, 1207 North Pitt St., Alexandria, Va. *Siphonaptera.*
'30. TRAVER (MISS) JAY R., Fernald Hall, Massachusetts State College, Amherst, Mass. (F. '35). *Ephemeridae.*
'30. Travis, Bernard V., Box 3391, Orlando, Fla. *Culicidae.*
'39. Trembley, Helen L., National Institute of Health, Bethesda, Md.
'34. Trippel, A. W., Indiana Dept. of Conservation, Box 408, Auburn, Ind. *Chrysomelidae.*
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